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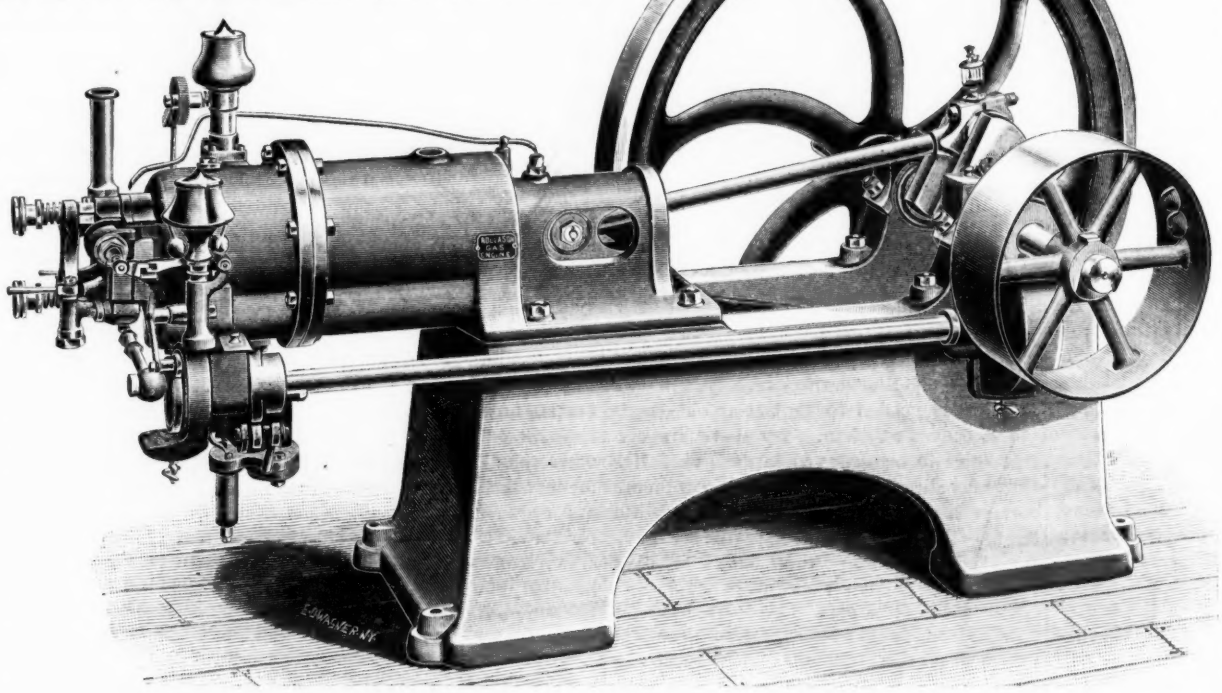
The Rollason Gas Engine.

On this and the succeeding page we give a general and detail views of a gas engine, which, though new in this country, has been for some time manufactured and sold in England, where it was invented by Mr. Arthur Rollason. The engine has been illustrated in its English form by some of our contemporaries, but our engraving shows it as now built in this country.

The engine is of the three-cycle type, *i. e.*, the crank-shaft makes three revolutions for each explosion of gas, and the governor acts to regulate the amount of gas supplied for each explosion, from the maximum down to a point at which it can no longer be used economically, when the supply is cut off entirely, and no explosion takes place until a sufficient diminution of speed occurs. This feature of a graduated supply of gas down to the point of its economical consumption, within which limits the ordinary regulation of speed is accomplished, before the supply is entirely cut off, is one of the distinctive features of the engine, its object being to secure close regulation with the highest possible economy.

Supposing the engine to be in operation, and that an explosion has just taken place, the piston moves forward to the end of its stroke, when the exhaust valve opens, and on the return stroke most of the products of combustion are expelled. During the next forward stroke of the piston a charge of pure air is drawn into the cylinder, and in like manner expelled by the second return of stroke, this being called the scavenger charge, and serving to cool the interior of the cylinder, and thoroughly expel all products of combustion. During the next forward stroke an explosive charge is drawn into the cylinder, compressed during the third return, and is then ready for another explosion.



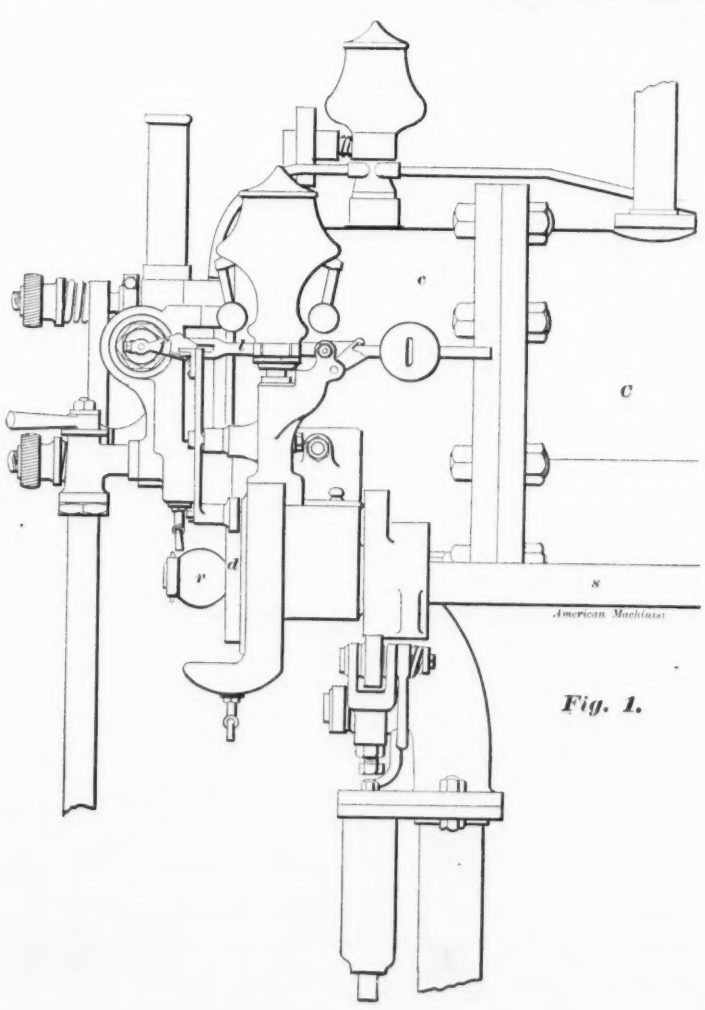


Fig. 1.

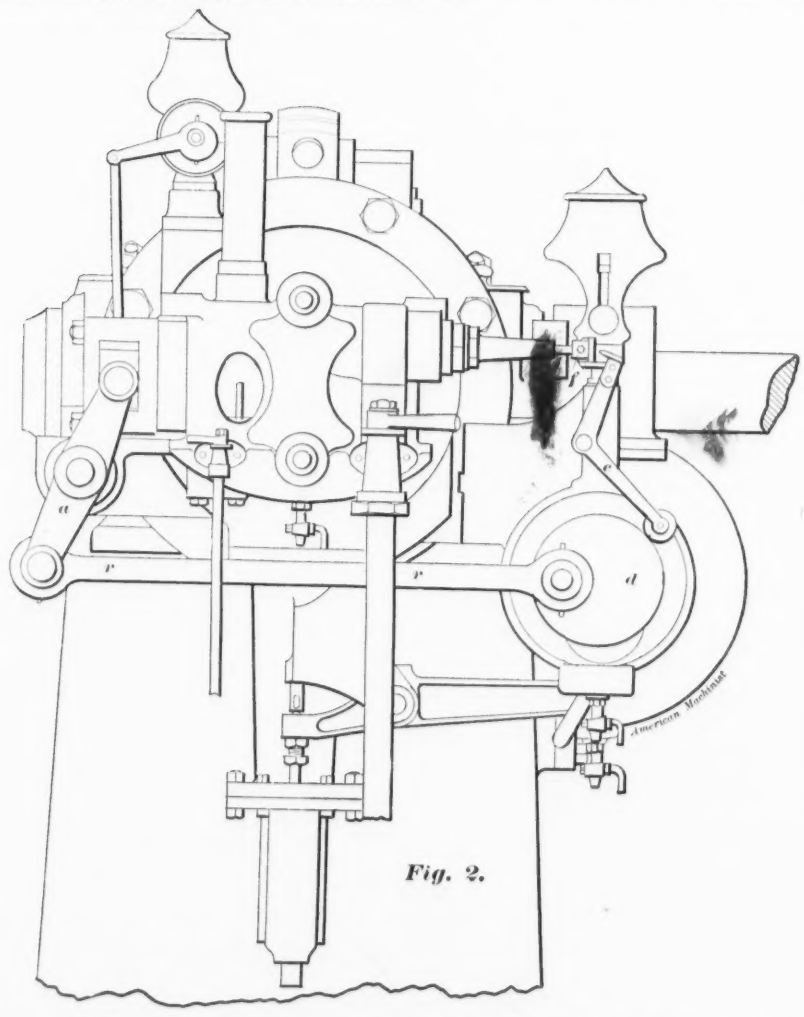


Fig. 2.

The side shaft *s*, which operates the valves, is driven by spiral gearing, and revolves at one-third the speed of the crank-shaft. At its rear end it carries a crank disk *d*, in which is a pin to which is connected the rod *r*, which, by means of the vertical rocking lever, or beam *a*, operates the slide valve *V*, this valve being the one which admits the explosive charge to the cylinder. The horizontal section, Fig. 3 (page 2), shows this valve with the arrangement of the ports and passages.

On the edge of the crank disk *d* there is a projection in the form of a cam, which actuates the lever *e*, seen above the disk in Fig. 2, the upper end of this lever, as it moves in, coming in contact with the piece *f* which is attached to the valve stem *v*, Fig. 3. When this stem *v* is thus pushed inwards it opens the poppet valve at the other extreme end of the stem and allows the gas to pass through the channel seen at the right, and thence through the slide valve *V* to the cylinder, after being mixed with the proper proportion of air which enters through the passage *D*.

So long as the poppet valve opens at all

it opens to the same extent and remains open for the same length of time at each cycle, but the amount of gas admitted during the continuance of this opening depends upon the amount of opening given to another valve which is below the poppet valve, the ports of which are opened by a rotary motion, this rotary motion being imparted to the valve by the action of the governor, which is driven from the shaft *s*, and by means of the lever *l* and connecting pin shown turns the piece *f*, which serves as a crank for turning the stem *v* as well as for a contact piece by which it is moved endwise for opening the poppet valve. As the governor balls rise with increasing speed the piece *f* is raised higher, diminishing the opening for the flow of gas until it may be raised sufficiently to cause the upper end of the lever *v* to pass under it, when no endwise motion is imparted to the stem, and the poppet valve is not opened.

There is a weight which is adjustable on a lever connected to the governor in the usual manner, by which the speed of the engine may be varied at will, the object of this being mainly to slow the engine down when for a short time no work is to be done.

The cylinder is jacketed with water to keep down the temperature, this jacket being shown at *B*, Fig. 3. The combustion chamber *c* is protected from the cooling effect of this water by the chamber *A* which surrounds it, and is filled with a non-conducting substance.

Ignition is accomplished by a continuously burning jet, which is brought into communication with the charge by the movement of the valves. A positive oiling device is located on top of the cylinder, all parts of the engine being automatically lubricated while running.

The combustion chamber is bolted to the cylinder, so that it and the attached parts may be readily removed when desired, and all parts are easily accessible for inspection or repairs.

Professor B. W. Kennedy, of London, made in 1888 a very thorough test of this engine under varying conditions, and his report of its performance, published in *Engineering*, May 4 and 11 of that year, is very creditable to it. The report is too long for publication here, but the results as to its efficiency are summed up as follows, being the average of four experiments:

Percentage of whole heat of combustion turned into work.....	19.6
Percentage rejected in jacket water..	33.
Percentage rejected in exhaust.....	43.1
Percentage rejected in blank charge and unaccounted for.....	4.3
	100.0

The mechanical efficiency of the engine on net indicated horse-power during the trials ranged from 86.1 to 90.8; and the consumption of gas per indicated horse-power per hour 20.67 feet to 21.68 feet.

Arrangements have been made by the Electric Manufacturing and Gas Engine Co., of Greenbush, N. Y., for the systematic manufacture of these engines in the best manner, and in sizes from 2 to 13 horse-power, and they may be seen in operation there, or at the general sales office, Rollason Gas Engine Co., 134 Liberty street, New York City.

It Was All Luck.

Recent returns from the High Bridge police strike say:

"Policeman James Corbly, while standing on the Morris Dock station of the Northern Railroad at a quarter past eight o'clock last night, saw a man with a lighted lantern attempt to cross the track in front of a freight train bound south. The lantern was thrown high in the air, and was picked up by the officer and brought to this station. A search failed to find the man, who is supposed to be Thomas McGough, a fireman employed by the Potter Dredging Company." It was afterwards learned that McGough was caught on the cow-catcher of the engine of the train and was carried on it to Tarrytown, where he was taken off not seriously injured.

Drill Jigs.

By A. D. Pentz.

There are two reasons why drill jigs are designed. First, more accurate and uniform sizes and positions of holes are desired, and second, a greater production is required, or a smaller cost for a known or predetermined production. Both these requirements are easily filled if the comparison is to be with hand-work, or to poor existing jigs. But always to get the desired results where a new jig is needed to replace an old one is not so easy a problem. Yet there are certain rules to be observed in designing jigs that may direct the inexperienced to more correct results than would be obtainable did he not know them. These rules I have found to be good in practice, but possibly there are other rules that are as good, and which I should be glad to know.

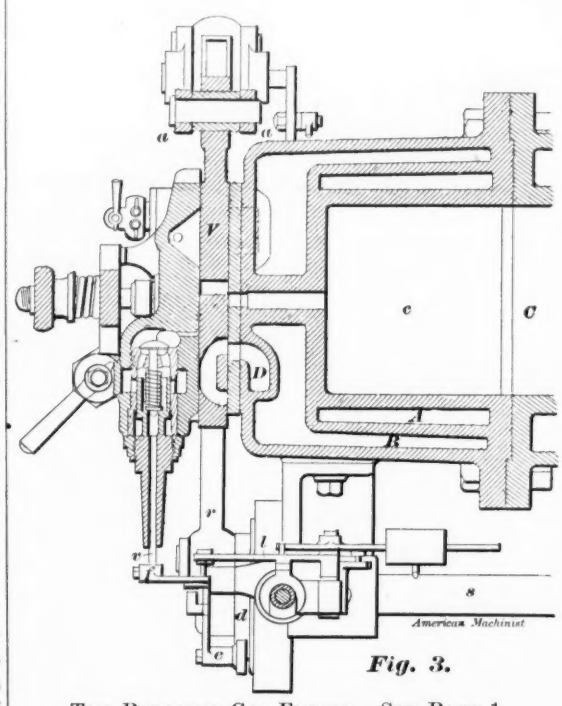


Fig. 3.

The Rollason Gas Engine.—See Page 1.

First. The piece to be operated on should have its seat and stops permanently attached to the frame or body of the jig, and not to an attachable or movable part of the jig. This frame is the part that stands on the table of the drill press, and no matter how many positions or elevations this frame may take on this table, the feet that support it should be permanently attached to it. The observance of this rule will insure the piece being properly placed on the table of the drill press.

Second. The bushings for guiding the drills should also be permanent parts of this frame, and not attachable or movable elements, because the seats and stops must be in constant and rigid connection and relation to the drill bushings, otherwise there will be no certainty of effect. For if one bushing be in the frame and another in the clamp or other movable part, the relation of these bushings may depend on the size of the piece, and on the care of the operator who places it in position, and there will be no uniform results possible.

Third. A drill jig should drill every hole in a piece at one setting. If it be possible to always observe this rule, the proper relation of any one hole to the others will be always maintained, but this effect will fail if there be a resetting, no matter how carefully it be reset, or whether such resetting be made in one jig or in many. Of course, if there be mechanical difficulties in the jig that cannot be overcome, that ends it, but if it be a question of drill spindles, it is better to use two or more drill presses, or even to change the drills in the spindles.

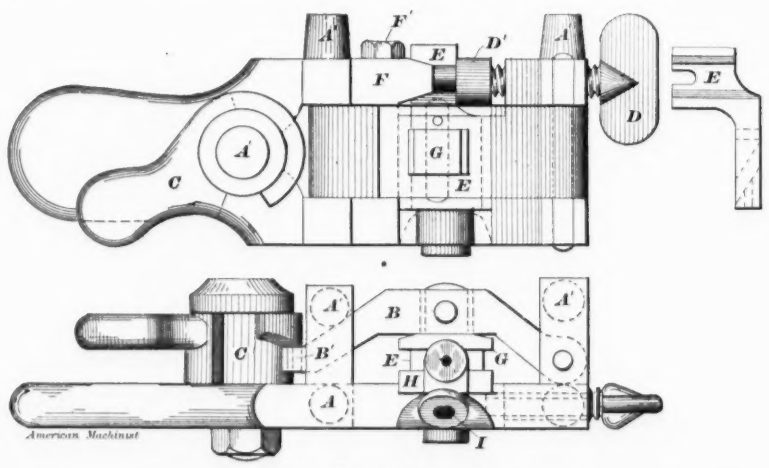
Fourth. The seat and stops in a drill jig must be made so that they may easily be cleaned; all the cuttings, dust, oil and dirt must quickly and certainly be removed, and these points must be where they can be quickly inspected for cleanliness.

Fifth. The clamps, screws and other means to fasten the piece into the jig must be designed and made to be so nearly instant in their action to fasten and release the piece that it is as quickly handled in this respect as possible. These clamps, etc., should, as nearly as possible, oppose in direct line the thrust of the drill. In this, as in all operations, the piece should be held in relation to the three dimensions of space—width, length and thickness—rigidly, and much more rigidly than the calculations show as safe.

Sixth. The jig should be made, if possible, so that the drill shall enter the most important holes from their most particular ends.

Seventh. Where a jig and its piece weigh more than fifty pounds the jig should be made "skeleton" as far as practicable. The expense of a steel forging is sometimes paid for in a few days, in the difference in amount of work done in a light jig easily handled, in excess of that done in a clumsy, heavy one that is frequently called a "man-killer."

Eighth. Where a piece has one or more holes in it that consume considerable time in drilling them, two drill jigs should be made, and while the automatic drilling feed is at work in one jig the other may be emptied, cleaned and refilled.



Drill Jigs.

Ninth. To determine whether a piece should be drilled first or not is quite simple. If the surfaces on a piece are further spread than the holes in length and width, and are more nearly coincident with the outlines in these dimensions, so that the piece will, when machined on these surfaces, lie flat on them, then make these surfaces first. But if the holes are further spread, large and long enough to do the work, then drill first. In either case, when the results of a first or other operation are used as positioning points to do an important subsequent operation from, then all other important subsequent operations of any kind should be done from the same points. This will assist harmony of results in the finished work in reference to standards.

Tenth. The bushings in drill jigs should not be shorter in length of holes than the diameter of the drills, and they should not be longer than three diameters. When a bushing is too short it reduces by wear the size of the drill near the point, and soon it will not "clear," but will bind and break. When a bushing is too long it chokes the drill with cuttings and dust, and this binds also. A bushing should not touch the piece, but be away so far that the lips of the drill are entirely clear when the point of the drill is on the surface of the piece. This will help to avoid choking in cast-iron, and prevent possibility of the corner of the lip being chafed in the bushing, and these corners from cutting the bushing. Bushings should fit drills as close as practicable, but unfortunately that is not as close as desirable. Dust, chips and expansions require more room than one not familiar with jigs on practical paying work would imagine.

I have often made drill jigs that transgress these rules, as all will have to do, but, if it is possible, I make them on these principles, and I expect no serious dissent from them.

In this sketch is shown a jig made in 1870, and which was still in use in 1888.

Drill Jig for Small Piece.

The frame *A* is of machinery steel, and should be well case-hardened, to prevent mutilation from the careless use of drills. It will be seen that the feet *A'* and all the bushings are rigidly attached to this frame. The clamp *B* is of tool steel, and the end *B'* is hardened. When the clamp *B* is released from the cam *C* it should fall out when the frame is turned upside down, and should turn on its hinge clear of the piece *E*. When the clamp *B* is turned back the piece *E* is alone held to its stop *F* by the wing screw *D*, which has a loose cap *D'* on its point. The seat or bolster *H* fits the lower shape of the piece *E*, and determines its position when the shoe *G* in the clamp *B* forces it downward. The stop *F*, which fits the working part of the piece *E*, is made so it can be replaced when worn. It is hard tool steel, rigidly fixed to *A* by the screw *F'* and two dowel pins. When this jig is turned to drill the angular hole *I* it is laid in a V block of proper inclination. This jig is made on correct principles, and while it teaches but little directly, it should suggest much. I do not know who designed it. I added the piece *F* to facilitate repairs. It has always been considered by mechanics as one of the first jigs ever made that filled the bill.

Modern Development of the Steam Engine.

By Harris Tabor.

Fifth Paper.

It is hard to determine the conditions in the compound engine that give its superior economy. That there are a number, none will deny, but who can determine the exact value of each? There is no doubt about the type of engine having an influence, and a decided one. A glance at the catalogues of a few builders furnishes a very good object lesson. If one will do this he will find that the maker of high-speed engines will determine the most economical point of cut-off at one-fourth of the stroke for ordinary steam conditions, say eighty or ninety pounds at the boiler. He may give as a reason too much condensation if an earlier cut-off be used. The builder of Corliss engines, or of any of the releasing valve gear type, will suggest a cut-off of one-fifth under the same conditions of steam. It is fair to assume that these respective builders understand what they are doing; they have been building these engines for years, and their catalogues are made after years of experience in running their respective engines, and carefully studying the best elements of practical economy. Each is right. Undoubtedly the high-speed engine will give as good economy, and more work, cutting off at one-fourth. It is equally true that the engine with re-

leasing valve will be quite as profitable to its owner when closing its valves at one-fifth of its stroke as when the governor trips a little later.

Here we have contradictory conditions and results. One man will allow steam to follow a little later, to avoid too much condensation; another will insist upon a greater expansion, with no fear of liquefying the steam. If these conditions were only occasional we might question the wisdom, but since they are the result of extended practice we must accept them as giving the best all-around duty. One of the advantages of the high-speed engine is small space for a given power; a later cut-off increases this advantage, but the builder, in this age of competition, would not dare to go beyond the limit of economy for the sake of added power, so we may assume that the quarter cut recommended by these makers is the best. On the other hand, the Corliss people might make their cut-off still later, and have their engine amenable to the governor, and we must accept their ratio of expansion as the most economical. The above conflicting practices would suggest that condensation, while an important element of waste in expansive engines, is not the only one, and, possibly, not the greatest. I believe that due prominence has not been given clearance in discussing the steam engine from the standpoint of economy, and it is the purpose of this paper to give it some expression.

In the foregoing comparison of different types of engines, clearance undoubtedly exerted a greater influence than any other one condition. The construction of the high-speed engine is such, with its relatively short stroke, that the clearance must be much larger than in the releasing valve type; its valve gear is usually such that one valve performs the functions of admission, cut-off, release and compression, and all these points, except admission, vary with the cut-off. Here we have another condition that calls for large clearance, viz., an early compression when the engine is running under light load. It will be seen that the short stroke engine is, of necessity, an engine with large clearance, which is aggravated when a variable compression is a feature. Conversely, the releasing valve gear is, from necessity, an engine of slow rotative speed, where great power is obtainable from long stroke. The valves are all fixed in their action, except the cut-off; we have here an engine with small clearance as a feature in its construction. In one case the clearance will vary from eight per cent. to twelve per cent. of the piston displacement, and in the other from two per cent. to three per cent. of piston displacement. Here we find at once a reason for the better duty given by the engine with the later cut-off and greater clearance, and the cause for higher economy from the engine with reduced clearance and greater expansion.

To fully understand the volume of clearance it must be calculated from the point of cut-off. In the case of an engine with a clearance equaling ten per cent. of the piston displacement, it will be seen that this waste room becomes enormous when considered in connection with an early cut-off, and when steam is allowed to follow full stroke the waste room will hold one-tenth of all the steam that goes in the cylinder. Here we find a condition that is antagonistic, from an economical standpoint, to an early cut-off, and one that shows the wisdom of the high-speed engine builder in recommending a later admission of steam than his rival, who has a much smaller waste room at the end of the stroke.

The system of compounding, or expanding through a number of cylinders, reduces clearance, or rather reduces the waste due to clearance, just in proportion as the steam is expanded to a lower pressure. If the steam be expanded until it has only half weight for a given volume before it is exhausted into a second cylinder which is to take the remaining work out of it, the effect has been to reduce the amount of steam necessary to fill the clearance, and consequently to reduce the waste. The farther expansion is carried through a train of cylinders, the greater will be the reduction of waste due to clearance. This is shown from the fact that the high-speed engine, expanding steam much less than the Corliss, will show a greater gain when changed from simple to compound than its rival under similar conditions. Clearance should be considered in connection with condensation. If filled with compressed steam it undoubtedly reduces condensation; it distributes its heat directly against the inner walls of the cylinder, and at the time (just before the admission)—when it will do most to reduce condensation; but in considering its value as a heat distributer we must not forget to look upon it as the robber it is. Both are elements of loss, and should be reduced to the greatest extent. Compounding does reduce both, and at the same time reduces another loss, namely, leakage.

The real effect of clearance upon the economy of the steam engine has never been determined. Cottrell gives it credit for a limited tendency to dry the incoming steam, and even insists that much of its loss may be corrected by compression. Indeed, he goes so far as to say that in any engine where steam is expanded to the atmosphere and compressed to initial pressure we have an ideal engine; such an engine, he claims, is without clearance.

While there may be truth in the foregoing claim it does not follow that such conditions always make an economical engine. If we take an engine with two per cent. clearance, expanding to atmosphere and compressing to initial pressure, we get a very pretty diagram, and one that will show a fair load and most excellent economy. On the other hand, if we take the same conditions in an engine with twelve per cent. clearance—and there are plenty of engines on the market with even more—we find that the expansion and compression lines run so close to each other that the effective area of the card is scarcely more than enough to run the engine, without load, to its rated speed. If, in this latter case, we have an ideal engine, we certainly have not a commercial one.

Just how much compression does toward counteracting the evil effect of large clearance has never been determined. In considering compression we must not lose sight of the fact that it does more than plug an empty space. If it had no other effect its efficiency might easily be determined. It is a strong factor in reducing initial condensation, distributing its heat, as it does, over the inner walls of the cylinder, just before the admission of steam. It is not necessary to have large clearance to produce this heating effect. The temperature due to compression runs as high with two per cent. clearance as it does with ten; hence if we have a small clearance, with judicious compression, we get all the benefits without reducing the diagram for effective work.

Drafting-room Points.

BY WALTER B. SNOW.

The only staple articles of importance consumed with any degree of rapidity by the draftsman are paper, tracing cloth, and blue-print paper. Consequently the best attention is generally given to their quality and price. In the line of paper there is a broad field and many varieties from which to select, but in the case of tracing cloth, two or three makes seem to cover all that is first quality in the market. As there are only two sides to the cloth, there can be only two opinions as to which side is best for general use. No one questions the beauty of finish, for ink work, upon the glossy side, but, to the writer, there are advantages in the use of the dull side that outweigh this feature. First, as the cloth always comes rolled with the dull side out, and as the finished surface is favorable to the cloth remaining rolled in the same manner, or at least curled up at the corners, when laid out flat, no readier means to avoid this difficulty appears than to draw upon the dull side, which will compel the cloth to remain flat and do away with curled corners. A second and very important advantage in the use of the dull side lies in the fact that it is the only side that will allow of the use of the pencil to make visible marks. As pencil notes and corrections upon tracings are often of great convenience, surely there can be no great objection to the use of the dull side. A plentiful use of chalk will guarantee a good working surface, and good ink work can be readily erased if necessary.

Blue-print paper is so rapidly increasing in use and decreasing in price, that figures that governed its economical use a few years ago have no bearing now. It certainly can be coated by hand no cheaper now than then, but it can be purchased already coated at such a figure as to preclude the possibility of economy in hand-coating, except in large quantities. In coating in small lots by hand, the time consumed in getting ready and clearing up forms too large a proportion of the total time required for the work. It is not many years since draftsmen were paying $3.25 per 11-yard roll for prepared paper 36" wide. Now, equally good paper can be purchased for $5 to $6 per 50-yard roll of the same width. Being tightly rolled, it is practically impossible to spoil more than a yard of it at a time by exposure, while hand-coated paper in sheets is always liable to change under the best treatment.

A great deal depends, in the use of blue-print paper, upon the means provided for keeping and cutting it. A very convenient arrangement consists of a high but thin box, some 30" high, and a little longer than the paper in rolls, set on the floor against the wall, provided with a tightly-fitting turn-down door in front, painted black inside. In the upper part of this box, but separated from it by a partition, may be arranged a rod and end bearings for carrying a roll of stock, the working edge of which may be slipped through a narrow slit in the front of the box and parallel to the axis of the roll. A sliding knife arranged upon a guide bar just above the slit will permit of cutting off at a single stroke sheets of any desired length, without exposing any more of the roll than that cut off.

The advantage of standard sizes in drawings is evident when it comes to the use of such a device. If any discretion has been used in the choice of standard sizes, paper and cloth can be readily purchased and used without waste. Thus, in the writer's case, two sizes, 18"x26", and 24"x36", are used, and only 36" wide stock is required to cut either size without waste.

Such standard sizes also allow of cutting up drawing paper and tracing cloth in large quantities for future use. By the use of the device described above, tracing cloth can be cut in any quantity and kept in stock, avoiding the customary but inconvenient practice of cutting off from the roll as desired. There are no waste pieces of all conceivable shapes and sizes to worry the economical man because they never seem to be used up.

As the value of an ordinary shop blue-print is seldom over ten cents—in the case of the 18x26 size just cited only four cents for actual cost of paper at the price paid by the writer—there is such a thing as false economy in trying to use dirty and defaced copies, or spending too much time in hunting up missing prints. It is a very simple matter to waste more than the value of a blue-print in the time spent in searching for it.

They Do Not Use Valve Lubricators.

My business of drumming takes me to a great many railroad shops, and it is my practice to gently entice the man in charge out to the roundhouse, that we may have the excuse for swapping stories about what happened in the flowery mystic past, for I love to hear about the days when a 14 × 22 engine would surpass the performance of the big engines that are growing so common nowadays. Years of experience from fireman to master mechanic gave me the means of picking up a few incidents of railroad life that can be retailed to bring forth others.

While calling on my old friend Primus a few weeks ago I found him saturated with vanity about a new ten-wheel freight engine that had been at work for a month or two, and said to be of the Primus design. We strolled together to the engine-house, and found a really handsome engine, which seemed to merit all the praise we were ready and willing to lavish upon her.

The engineer was there, and on hearing my complimentary remarks about the engine concluded at once that I knew what I was talking about, and he freely pursued the subject of his own volition.

After expatiating at some length on the fine points of the engine he remarked: "But there is one thing about her that is funny. She will sometimes go lame near the top of summit grade, and there is not a thing the matter with her. Not a bolt or nut loose. She will be lame there, and nowhere else. It is just as she crosses over Rabbit Creek Bridge that you may expect her to step onto three legs, and then she is as likely as not to lay down with the train."

As he finished there was a strained note in the man's voice, his eyes had a far-off look in them, and he acted as if he believed that some occult force rose from Rabbit Creek and temporarily injured the engine.

There was an incredulous smile on the visage of Primus, and he mutely remarked: "Did you ever see such cranks as some engineers are, anyhow?

In answer to the very eloquent look, I said: "She has long, bent eccentric rods, large, unbalanced valves, no automatic valve lubricators, and summit grade is a long, hard pull."

"But what has that to do with the engine getting lame?" questioned the master mechanic.

"Mere cause and effect, that is all. When the valves get dry they are hard to move, and spring the long eccentric rods."

"I must have the rods made heavier in the other engines that are coming," was the decision Primus at once jumped at.

"How would balancing the valves and putting on sight-feed cups do?"

"Balancing valves and lubricators!" exclaimed my friend, with a frightened look on his face. "Why, the general superintendent would call me crazy if I asked for those expensive additions to the engines."

I perceived at once the force of the objection, and how strongly it came home to the man responsible for the expense of operating the engines.

Business took me to the general superintendent later in the day, and there was no difficulty in getting him to talk about the new freight engine. I also spoke of the need for lubricators and balanced valves, and the saving in fuel, oil, and expense of repairs that would result.

"Saving!" he cried, with wrathful energy, "it is wasting you mean. There is nothing thought of among you fellows but how to spend money. I have run this railroad thirty years without lubricators or balanced valves, and I am not going to give into them now. The next thing they will be asking for air-brakes on the engines."

I have no reason to believe that the lubricators or balanced valves were ordered.—*Sam Short in The National Car and Locomotive Builder.*

Oversize Taps.

Every machinist knows that it is not a good thing for a screw thread to bear at the top and bottom; hence the practice (in "sharp" threads) of turning the screw a little undersize, and boring the hole for tapping a little oversize; even then, in some metals, the stock will crawl down (flow), particularly if the tap is a little dull, so that the tapped thread will be sharp on the bottom, and make a good fit impossible.

This may be overcome by cutting the tap with a tool which has the point flattened by grinding exactly to the extent that it is desired to have the thread flat on the bottom of the tapped hole. It is evident that it would be impossible to tap a sharp-bottomed

thread with such a tap, and if the thread of the screw is turned undersize, or filed a little flat, we obtain what is wanted, *i. e.*, a thread bearing on the sides, and clearing at the top and bottom.

Since the advent of the United States Standard thread (so-called, but more properly the Sellers' or Franklin Institute thread,) it has become customary for many to turn taps enough oversize to allow the threads to come sharp on top, which gives a clearance on top of screw threads, while the screw itself is cut with a sharp-pointed tool or sharp-bottomed die, which gives the clearance top and bottom, the taps being cut with a flat-pointed tool as mentioned above.

It then becomes necessary to know how much oversize to turn the taps, in order to have a sharp thread at the top, and to tap a hole to fit a United States Standard screw.

It is found by trigonometry that the amount to be added to the diameter of a tap for a United States Standard thread of one to one inch is 0.2165, and it follows (by geometry) that the amount to be added for any thread is 0.2165, divided by the number of threads to one inch; for instance, a tap for a one-inch diameter screw (8 threads) would be $1 + \frac{0.2165}{8} = 1.0271$, outside diameter.

The following table which I use in my own practice will save calculating every case:

$0.2165 \div 8 = .0271$
$9 = .0240$
$10 = .0216$
$11 = .0197$
$12 = .0180$
$13 = .0166$
$14 = .0155$
$15 = .0144$
$16 = .0135$

W. L. CHENEY,
in *The Practical Mechanic.*

Chaese's Quadruple Expansion Marine Engine.

These illustrations are taken from a working model of a disconnective quadruple expansion marine engine built to a three-quarter inch scale.

The principal dimensions of the full-size engine would be: Diameter of high-pressure cylinder, 14″; first intermediate, 22″; second intermediate, 32″; low pressure, 45″; stroke, 28″. Boiler pressure, 200 pounds per square inch. The engine is arranged on the tandem principle, the high pressure and first intermediate cylinders forming the forward engine, the second intermediate and low-pressure cylinders, the after engine. The cylinders are jacketed with steam direct from the boiler, entering through an inlet valve and dripped into condenser. This enables them to be thoroughly heated before opening the throttle. At the same time a vacuum may be produced by starting up the circulating donkey pump. In addition to the steam jacket is a coating of asbestos, and a lagging of alternate strips of mahogany and white maple, which last has an effective appearance. The relief valves at each end of cylinders are made extra large; ample provision for draining cylinders and jackets is provided, together with indicator cocks and connections. The main valves are all of the piston type, and their upper portions in the upper cylinders are made slightly larger; this excess in area perfectly balances all the valve gearing beneath. The cylinder pistons are attached to their rods by means of an adjustable screwed collar. This arrangement has the same features of rigidity as the usual conical rod and nut, but in case of accident, or for adjustment, allows the piston to be readily removed. The piston rods to the lower cylinders are made considerably smaller than usual by this method, thus slightly increasing the effective cylinder area. The stuffing-boxes between the upper and lower cylinders are each made in two halves, bolted together, and furnished with split collar bushes. A long sleeve is utilized in place of one set of stuffing-boxes; the sleeve also serves as an excellent guide to the piston rods. This arrangement dispenses with one set of stuffing-boxes, shortens the distance between cylinders, and enables obstinate cases of hard packing to be more readily dealt with. The upper cylinders are supported on six short vertical columns, any one of which may be readily removed for overhauling and repairs.

The lower cylinders are supported at the back on the condenser, and in the front on cast-iron columns, the after column being utilized as an oil reservoir, and on this column the engine counter—which is of very simple construction—is attached. The go-ahead slides are detachable, and the shoes provided with brushes which dip into oil-boxes at the foot of guides.

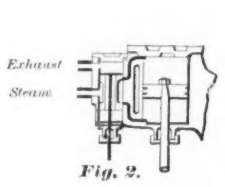


Fig. 2.

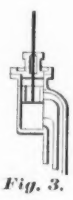


Fig. 3.

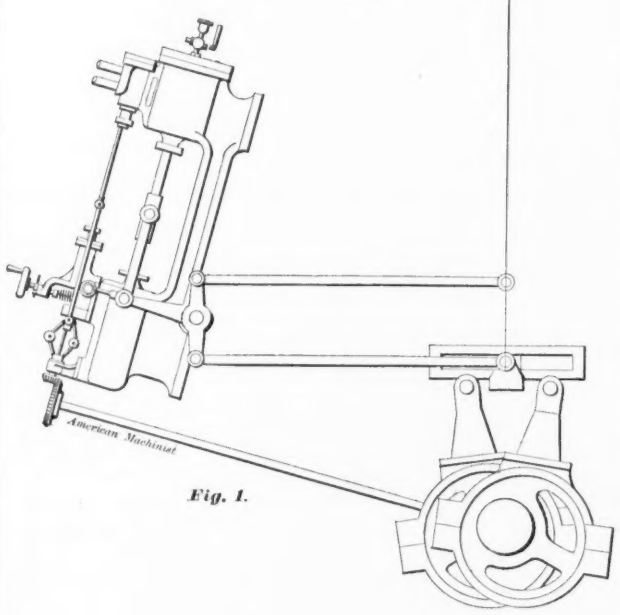


Fig. 1.

The condenser is very efficient, the circulating water being distributed from the pump in two directions—around the condenser and through the tubes. Large, easily accessible doors to the water side, with manhole and hand poles to the steam side, are provided; also snifting valve at lower point. All the pumps, excepting the donkey, are worked from the main engine. There are two feed-pumps with separate air vessels, stop and relief valves; either pump is sufficient to supply the boiler under ordinary circumstances. They are bolted on considerably below the hot well.

The auxiliary feed may be connected either to the circulating water or to an evaporator.

The air-pump is single-acting, and placed low down on the condenser. The circulating pump is double-acting, and of sufficient capacity for water of any temperature, the supply being, of course, regulated by main injection valve. There are also two bilge pumps with their necessary stop valves and connections. All the pumps are supplied with pet cocks, and the hot well with water gauge, manhole and vapor pipe.

The crank-shaft is in two sections, flanged and secured in the center by a dowel, which can be removed readily in case it is desired to run either engine separately. The main bearings have brass bushes to boxes; also oil boxes and syphon pipes.

The bearing surfaces throughout the engine are made extra large and well supplied with means of lubrication. The water service for cooling purposes is ample, and has universal joints for all parts; also hose connections for extreme cases. Back of the after main bearing a gear wheel secured to shaft engages with a worm driven from an auxiliary engine. By means of a clutch and swinging bracket the worm may be thrown out of gear without causing delay.

The auxiliary engine, when not in use as a turning engine, serves as a powerful pump for all purposes. It has two double-acting steam cylinders and pumps, and is remarkably compact.

Slotted crossheads are used; there are no eccentrics; a cam on the shaft gives the necessary lead and cut-off when running in either direction, and reversing is effected by reversing the steam, all the pipes, etc., being cast with the cylinders and chests.

The main engines are reversed either by hand or steam. The steam reversing engine consists of a steam and an oil cylinder, the pistons of which are connected together, and give motion by links to the reversing gear, which is a modification of the Allen straight link. By the method of suspending this link a sort of parallel motion is obtained, which greatly reduces the slipping of the block, and gives a quicker admission and cut-off.

By means of a two-way valve to oil cylinder and lever to steam cylinder, reversing may be done quickly or slowly, and the cut off fixed immovably at any point. The hand reverser consists of a small force pump connected with the oil vessel, utilizing the same levers as the steam. In connection with the steam reversing gear is a positive governor, very sensitive in its action, connected by gearing to the shaft, and having perfect control over the main engine.

The cut will explain its action.

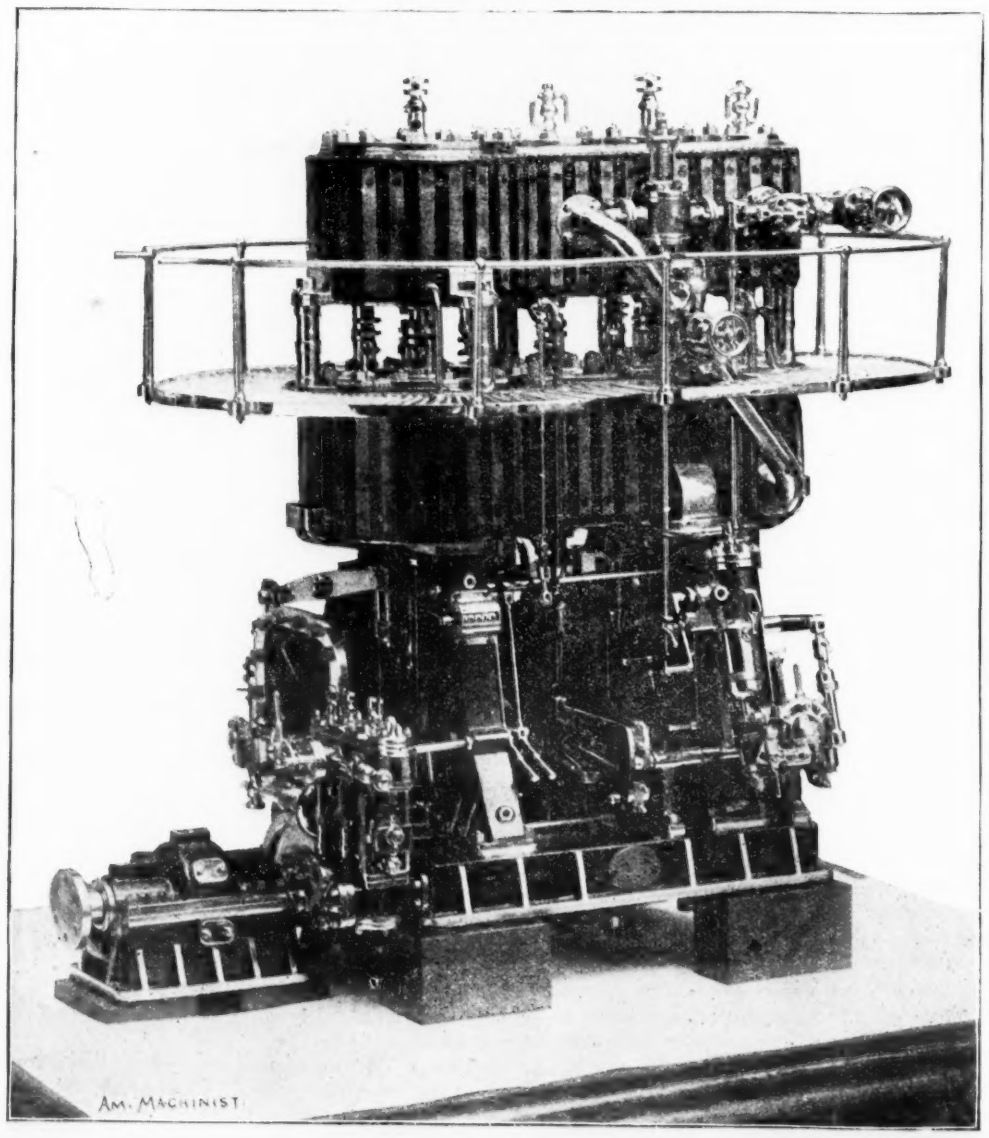
Fig. I is a general arrangement.

Fig. II shows the balanced valve to steam cylinder. Steam is admitted slightly to both sides of piston, and a short movement of valve in either direction by the sensitive governor reduces the pressure on one side of piston, the latter, of course, following in the direction of the reduced pressure, and moving the connecting link to valve spindle nearer to, or farther away from, the center of the slotted link, according to the speed of engine.

The same movement of the balanced valve opens the valve to oil cylinder as shown in Fig. III. When the engine is at its normal speed the oil piston is locked. Should any great acceleration of speed take place, due, for instance, to the breaking of shaft, the link would be thrown into mid gear, thus shutting off steam completely from each and every cylinder in the main engine, nor would steam be again admitted except by operating the ordinary hand reversing lever, which is not in any way connected with the automatic governor.

The disconnective features of the engine are as follows: In case the forward engine breaks down, it is disconnected by removing the dowel in crank-shaft.

The valve between the two intermediate cylinders, together with the throttle valve to H. P. cylinder, is closed, and the auxiliary pump used as a circulating pump. Steam is admitted to the second intermediate cylinder through the reducing valve, and the after engine is run as a compound condensing engine. This reducing valve is operated by a lever from the starting platform, and is useful as a blow-through valve for turning centers in starting. In case the after engine breaks down the connecting rod is removed from crank-pin and secured in an out-of-the-way position. The valve between the two



QUADRUPLE EXPANSION MARINE ENGINE.

intermediate cylinders is closed and connection made between first intermediate exhaust and condenser. The auxiliary pump is used as an air-pump and the forward engine then runs as a compound condensing engine. The thrust from the propeller is taken up on conical rollers running in oil, fitted with adjustable plates for wear; this arrangement reduces the friction considerably.

The engine takes up very little room fore and aft; every part is accessible for adjustments and repairs, and a system of duplication of parts is carried throughout.

The model of this engine is complete to the smallest detail, aside from the governor described, and contains upwards of 3,500 pieces. It may be seen for a short time at the home office of the Hartford Steam Boiler Inspection and Insurance Company.

New Tools for Watervliet.

The government has recently awarded contracts for quite a large lot of machine tools which are to be placed in the new gun factory at Watervliet Arsenal, West Troy, N. Y. The bulk of the order was secured by the Niles Tool Works, of Hamilton, Ohio; lathes for boring and turning 12″ guns; jacket lathes; three 60″, three 48″ lathes; four cylinder boring machines; 14″ and 26″ stroke slotting machines; a heavy boring and turning mill, and a 72″ planer being included in the list to be built by them.

Among the tools to be built by other makers are two planers (32″ and 44″) by the Pond Tool Works, Plainfield, N. J.; threading and slotting machine for breech mechanisms, by Detrick & Harvey, Baltimore; universal radial drill and 18″ and 26″ shapers by W. H. Warren, Worcester, Mass.; 22″, 30″ and 36″ lathes by the Fitchburg Machine Company, Fitchburg, Mass.; 24″, 36″, and 50″ drill presses by Gould & Eberhardt, Newark, N. J.; two universal milling machines by Pedrick & Ayer, Philadelphia.

The north wing of the gun factory contains a large number of Niles tools similar to those enumerated above, among these being eight heavy boring and turning mills, which present an unusually fine appearance. The Watervliet gun shops will be among the finest and best equipped in the country. The center wing is spanned by traveling cranes built by the Morgan Engineering Company, of Alliance, Ohio, who are now building an 80-ton crane for the new south wing, where will be placed the twenty-three gun lathes and two rifling machines now being built by the Pond Tool Works.

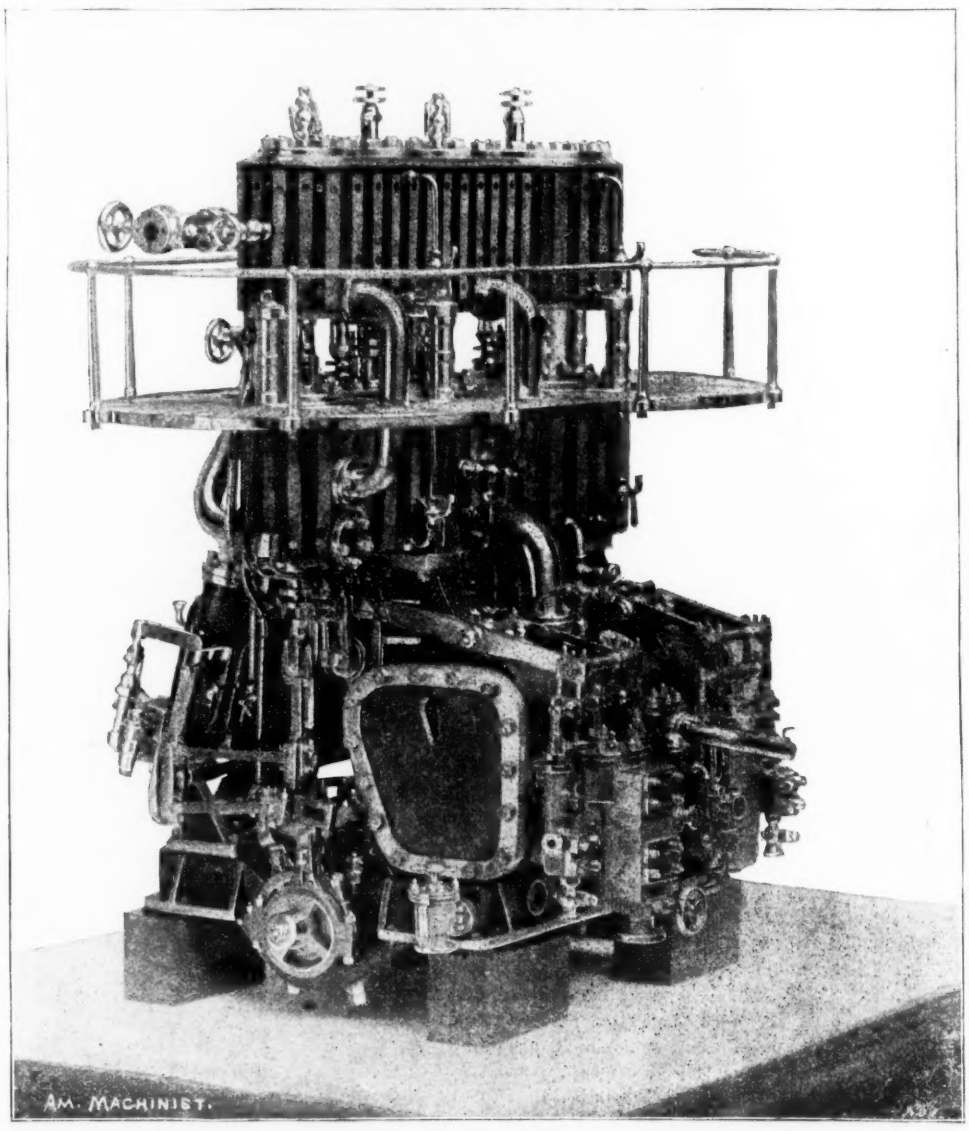
"Inventors" of ammonia engines are pretty sure to find plenty to listen to their schemes, as witness the following from *The Press:*

J. H. Campbell, the inventor of the engine, said yesterday: "I believe that the most skeptical engineer would acknowledge an economy in ammonia if he were to pursue this course: Substitute water for ammonia in the generator, and in all other ways work the water steam just as we work the gas. The engine that is now making 100 revolutions and propelling this boat against the tide twelve miles per hour would then drop to fifty revolutions, and would make about four miles an hour. There is an economy in running an ammonia engine that is seldom thought of, that is, the readiness with which it accommodates itself to the different speeds of an engine or to the different loads. Other than the economy of 50 per cent. of fuel, the advantages of the ammonia engine are a saving of all the cylinder oil, 95 per cent. of the water required for the boiler, a boiler always clean, no care as to the supply of water for the boiler, and greater comfort for the fireman, as rapid firing is not required."

The story is rather an old one of the man who stole a saw-mill one night, and going back the next night to steal the dam, got caught. This was the story, we believe, told by a prisoner to some inquiring body. But it is scarcely stranger than the stealing of the products of a wheat field in Kansas. Some one procured the threshing of the wheat, marketed it, and got away just about one thousand dollars ahead. It happened through the wheat being on rented land at considerable distance from the party who rented it.

Fine Houses for Workingmen.

An American naturally compares what he sees abroad with what he knows at home, and there are a few things that might be learnt by our growing cities from a study of Nuremberg. The growth, of course, is outside the walls, for there is no more room within them, and handsome residences in the front have often a factory chimney—itself neat and graceful, sometimes ornamented—rising behind, showing that the employer and his "hands" are near one another. These "hands" again are living in houses often built and decorated like villas, and kept as the houses of "gentlemen" would be in England. Of course they are "apartment houses," but they do not interfere with the look of the street, and one is sometimes surprised and pleased to see an old grandmother or a workingman, with a child or two, looking down from upper windows where the residence as a whole would not be out of place in Kensington, London, or in Fifth avenue, New York. In a word, the taste and habit of decoration, of which the old city is, and long ago was, a center, tell on the extensions of to-day, and produce results very different from what one sees in Sheffield and other industrial centers in England, or in our own dear Pittsburgh. In one particular, however, we are ahead of the Nurembergers. Driving through the new and handsome suburbs, I failed to see a single church. More Melancthons are needed hereabouts.—DR. JOHN HALL, in *The Mail and Express.*



QUADRUPLE EXPANSION ENGINE.—SEE PAGE 4.

The London *Engineer*, basing its remarks upon the report of the Amalgamated Society of Engineers, expresses the opinion that there is a general lessening in trade activity in Britain. It says:

"Small labor and wages disputes in a number of districts tend, of course, to add to the out-of-work members on the books; but this does not altogether account for the increase now taking place, which can only be attributed to a general lessening activity in trade. The reports from the various districts as to the condition of trade are for the most part not more than moderate, with declining activity returned in many places, and trade returned as actually bad in some. With regard to the fifty-three hours' movement there is no specially new feature to report, except that the reduced number of hours has now been conceded in the Bolton district; but the general slackening off in trade has operated against this matter being pushed forward so keenly as might otherwise have been the case. The only satisfactory feature in the report is the continued considerable decrease in the number of members on sick benefit, and these have now got back to something like the normal percentage."

What a Modern Gun Can Do.

Unless one is actually brought into business relations with the great science of modern warfare, it is difficult to conceive of the terrible power of the latest and largest guns. These engines of destruction, weighing 110 tons, hurl a projectile of solid steel 16 inches in diameter and nearly 4 feet long at a velocity of 2,079 feet a second. When tested recently, one of these guns sent a shot through 20 inches of steel armor, 8 inches of iron, 20 feet of oak, 5 feet of granite, 11 feet of concrete, and 3 feet of buck. Comparatively, a locomotive weighing 200,000 pounds would have to spin along the tracks at a rate of 135 miles an hour to strike a blow equal to that projectile. Think of the damage wrought in a railroad collision where the train speeds along at the rate of 30 miles an hour, and one may calculate the destructiveness of modern ordnance.—*Boston Traveler.*

The subject of steam distribution in the steam engine has come to be pretty thoroughly understood, and is very well applied in modern construction. No one at the present time will try for the theoretical limits of boiler pressure in the cylinder, nor will he permit construction that falls very much below it. There is loss in the attempt to get too near theoretical perfection, and there is loss in falling too much behind it. There are a great many things in steam engine construction that are never likely to be settled, except by tentative processes, but so sharp has been the competition that builders get very close to the best requirements. Perhaps the points that are farthest from being settled are the effect of clearance and compression. We believe there is ample room for further investigation on these points; in other words, we have very little faith in any figures that have yet been given on these points.

LETTERS FROM PRACTICAL MEN.

True Planer Platens.

Editor American Machinist:

No problem in the machine shop is more difficult than to maintain a perfect alignment in planing machines. However perfect a planer may be when new, it generally becomes more or less convex on the surface after a few years use. This tendency to become convex is generally attributed to the batter and friction of the work, but the principal cause of it, in my opinion, is the use of the stops, which are taper, and are driven more or less tight in chucking, and having a bearing only at the surface or top of the hole, their continued use expands the metal and elongates the surface, with the result of making it convex, and what is worse, it causes wear of the slides at the ends of the platen, and a corresponding wear of the bed, which gradually assumes a curved shape, making it impossible to plane work parallel.

As a remedy, I would suggest that the holes for the stops be drilled, and the lower end of the holes smaller and taper, and the stops turned taper, to fit. This places the expanding effect of the stops so low as to be practically neutral in their tendency to warp the platen. Our best planer man recommends the stops to be made round and parallel, not taper, but with square heads like a bolt, to facilitate getting them out, and to present a flat surface to the work.

C. W. CRAWFORD.

Brazil, Ind.

[Planers have for some time been made with round reamed holes in the platens intended for turned "stakes" with square heads, though this manner of making them is not, we believe, so nearly universal as it deserves to be. Such stakes hold work just as well as any other, and have no tendency to spring the platen.—ED.]

The Industrial University.

Editor American Machinist:

As I have, in every shop I have worked in, seen a great number of young men growing up and beginning life for themselves almost entirely devoid of theoretical knowledge, and often without even the rudiments of mathematics, I have sympathized greatly with those who have recently written in regard to an industrial university.

Such an institution should, as Prof. Sweet recommends, combine the theoretical and scientific studies with the every-day machine shop practice, and should be so maintained and supported as to be within the reach of all, there being, I might say, thousands of young men who would be glad to take any such advantage which might be offered, but who, from lack of means, are unable to get a right start; and, therefore, to find one

who has had enough energy and determination to excel, to say "I will" and resolve to be something better than an ordinary workman, is a rare exception.

On the other hand, when a young man is enabled to get a right start he will generally be found to continue to improve if he has the least spark of true manhood or ambition within him. Therefore the wish of every right-hearted man should be to try to do something to hasten the day when the poorer class of workmen may be enabled to improve their minds as well as their hands, and set themselves on a more equal footing with their richer neighbors.

ONE OF THEM.

Babbitting Boxes.

Editor American Machinist:

I notice in your issue of Aug. 27 B. B.'s account of his trouble in babbitting boxes. Perhaps I can help him out, if he will take the necessary pains, and there is no magic in my way. The ordinary method, if it can be so called, of babbitting machine boxes, is, I think, as stupid an affair as can be imagined. All other parts of a machine may be well made, but nine times out of ten, if the boxes, when of babbitt, are not hammered in and bored to size they are no good. The usual way is to set up the machine, lay the shaft in the bearings, putty up the ends if necessary, and then dump some melted babbitt into the space on one side of the shaft.

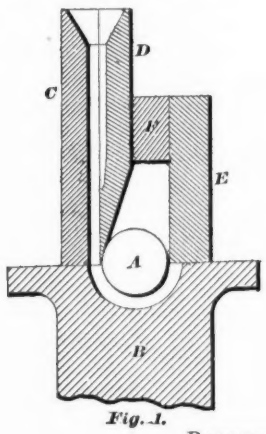


Fig. 1.

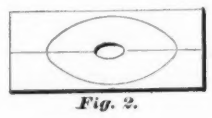


Fig. 2.

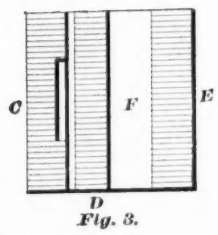


Fig. 3.

BABBITTING BOXES.

The babbitt is often thick and sluggish, and piles up on top of the box and against the shaft, so that the latter cannot be taken out of the box until the surplus babbitt has been chipped off, and when it is finally done there are usually one or more slack corners in the box, and the babbitt is so loose, on account of the pounding in digging off the surplus, that it is always a loose, shaky box, and of no use for a quick-running machine. When we carry a pattern to a foundry for a casting, the molder does not dig a hole in a pile of sand, or push the pattern into the sand and pour the melted metal into an open hole. He has a cover called a cope to his mold, and a hole to pour through, and he gets a head on his casting equal to the thickness of the cope, thus making the casting more solid, owing to the pressure. This is exactly what is needed to make a good babbitt box; something to pour through to give a head, and so arranged as to confine the babbitt within the bearing. There are various ways of accomplishing this object, but as I have never had more than one pair of bearings to babbitt at once, I have always made the cheapest thing I could think of, and it may be as good as anything.

In Fig. 1, *A* is the shaft, *B* the bearing, and between them is the space for the babbitt. *C*, *D* and *E* are three pieces of board, the width of each being the same as the length of the bearing, while the length of *C* and *D* may be from 8″ to 12″, according to the size of the box to be poured; *F* is a block between *D* and *E*, both of which are secured to it by wood screws. Piece *C* is secured to piece *D* by four wood screws, two on each side of the pouring hole, which may be bored with a ¾″ bit, or dug out with a gouge. The pouring hole should be round, or approximately so, from the top down to within 2″ to 3″ from the lower ends of pieces *C* and *D*, and equally in each, but at the lower end it must be all in piece *C*, because *D* is tapered on the inside, or next the shaft, as shown, to ⅛″ or even less. The upper end of pieces *C* and *D* is dug out to make a pouring hole, so that they will look like Fig. 2, while the lower end will look like Fig. 3, which shows the whole affair from the under side. It will be seen that the gate at the lower end is all in *C*, and that it is flat, so that it is easily broken off after pouring the box, or, what is better, sawed off. It will be noticed that *C* and *E* are marked on the lower ends, and *D* on the long bevel; these represent scores made with a three-cornered file, and they constitute vents to let the air out where the metal goes in. The more of them there are the better, but they must not be too large; the size of a common pin is plenty. White wood is as good as any to make this thing of, and it must be thoroughly chalked where the metal comes to it, every time it is used.

The metal must not be heated any more than enough to turn a straw color, and it should be poured quickly. Chalk the shaft, which will take up all oil, rubbing the chalk lengthwise of the shaft, and if the shaft is an old one with a glaze on it, you will do well to put it in the lathe and file it; a glazed shaft is more apt to heat than one that is fine filed. In using this arrangement, first chalk it thoroughly, and also the shaft, fix the latter in place, and secure it from rising, which it will do if not held down, as the metal has considerable lifting power, owing to the head. Next place the "what is it" on top of the box, and lay a heavy parallel on top of piece *F* to hold the thing down, then make the ends of your boxes tight and you are ready to pour. Don't rely on putty to make the ends of the boxes tight, because it won't stand the pressure.

If there are no collars on the shaft, either tight or loose, make some; wooden ones are as good as iron. If the ends of the boxes are rough and uneven, some cotton waste wound around the shaft, with a collar shoved up hard against it, will be sufficient. Where many boxes of the same size are to be babbitted, this thing can be made of iron, so as to be more durable than wood. After pouring a box, piece *C* is removed after taking out the wood screws which secure it to *D*, after which the rest of it can also be taken off, and the flat gate can be sawed off, as before stated. I have run lots of boxes in this way, and never had one miss. This arrangement is, of course, only for the lower half of a box, but I also pour the caps of boxes through a hole in two pieces of wood, which are fitted to the top of the cap, so as to prevent the metal from leaking. I think it a good plan to pour caps in the middle, and drill a small hole through the top near each end, to let the air out when the metal runs in. This method produces a very superior box; it is very little work to trim them up, and in ordinary sizes of boxes the babbitt is quite tight in the casting.

I hardly think any person who once tried it would go back to the old way. H. K. PORTER.

Editor American Machinist:

I would like to make a suggestion for the benefit of "B. B.," if you think it of sufficient value to publish. I have charge of the mold-making department in a factory making "brittania," which is a metal very similar to "babbitt," and, as our molds are of brass and iron, we have to overcome various difficulties to make them run up sharp.

One very important point is to have gates sufficiently large, and another is to provide an opening for the air to escape. A very noticeable fact is that the heated metal runs up sharp in a cold mold, which is not practicable for getting out a large number of castings, as the metal soon heats the mold. The operator therefore increases the heat until the proper degree is reached, which requires considerable skill.

But for making one casting, as for the lining of a box, the cold process may be used. Smoke the shaft well and place strips on each side, with openings for gates on one side, connected with a well-oiled clay dam, and smaller openings on the other side for "air vents." Heat the babbitt carefully, so as not to burn it. My practice is to heat until the skimmed surface shows a blue oxide, and when the box is large I pour when the babbitt is sufficiently melted to run. A very common mistake is to heat the metal too hot, which then shrinks and causes just such troubles as "B. B." has experienced.

A. A. B.

Tempering with a Lead Bath.

Editor American Machinist:

There may be several ways of tempering small steel pieces, but the quickest and simplest way I know of is by means of the lead bath. Below I give the results of my experience in tempering small pieces.

At one time I was employed by a firm who manufactured machine-made steel figures and letters, such as are used by machinists for stamping and marking pieces of machinery where they go together, and part of the operation was hardening or tempering them on the ends.

Our first method was by the use of a small portable forge such as is used to heat rivets in, and in it we placed a cast-iron cylinder open at both ends and about ¾″ thick and about 4″ to 6″ in diameter by about 8″ or 10″ high; in this cylinder were drilled a series of holes large enough to admit the steel pieces (shown in sketch No. 1), and radiating from the center.

Through these holes we placed the pieces of steel (or steel letters, as I call them,) to be hardened; inside of the cylinder we built the fire, and after we had placed the pieces of steel in place we would blow the fire with the hand fan blower until they were hot enough to dip (Fig. No. 2 shows cast-iron cylinder here mentioned). This method had some good points, but it had a good many bad ones, the chief one, from what I remember, was, it burnt the steel letters, and it was a slow method.

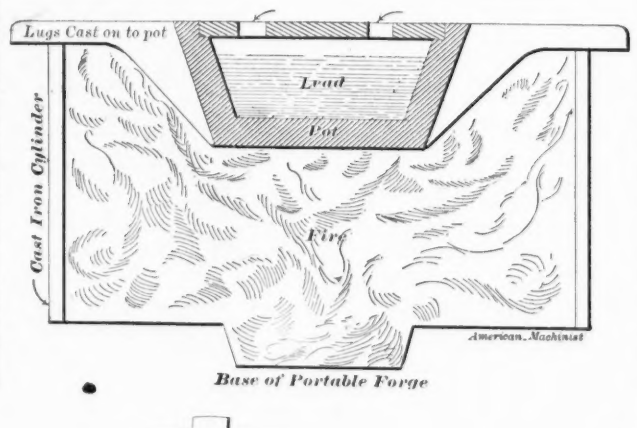
We next tried the lead bath. The first difficulty we struck was that the lead stuck to the steel letters, so we had to do something to prevent it. After experimenting we struck or tried the following solution, which always gave the best of results. Sometimes when the solution was not made right the lead would stick. If the lead sticks to the steel your solution is not made right. The recipe is as follows: Take equal parts of wheat flour and common salt (table salt pulverized) and mix together, pour in enough water to make it a thin paste, and stir it well with a spoon until it is thoroughly mixed together; it is then ready for use. While you are using it you will find that the salt will settle to the bottom; in that case stir it up again. The best results are to be had by keeping the solution as well mixed as possible. Always make a fresh solution before starting to harden, as the stuff gets sour and is then of little use, and the cost is a mere trifle.

The lead to be used does not matter. We used the ordinary commercial lead; reheating the lead does not injure it for this use, so far as my experience goes. The manner of using it may vary as the work requires, so I will only give the "modus operandi" of tempering steel figures and letters. In the first place one end only is hardened.

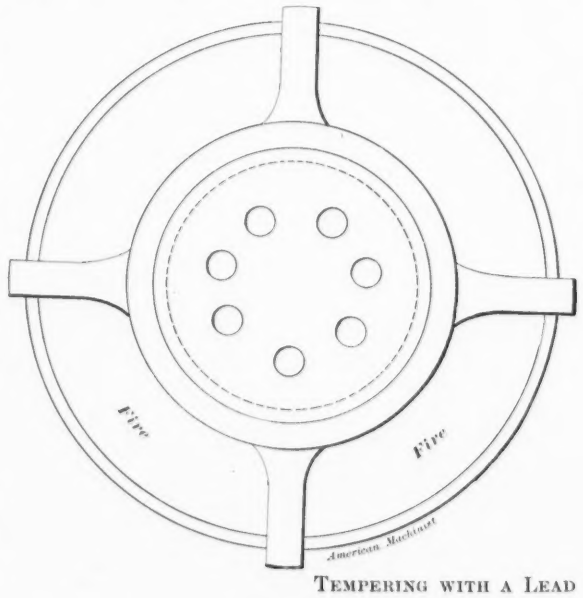
We had a pot of cast-iron like sketch No. 3. It is placed on a cast-iron cylinder, inside of which and around underneath the pot is the fire. The pot is also provided with a cover which had a series of holes drilled in it, ranged in a circle, through which we passed the steel letters to be hardened. The cover tended to prevent oxidation of the lead, and also kept the steel letters in a vertical position. A little pulverized charcoal thrown on the surface of the lead tends to prevent oxidation.

The lead must be heated until it is "red-hot." My experience has been that it can't be "too hot"; you can work right along in lead tempering without fear of burning your steel. The only reason I can advance for that is that the temperature of the lead is below the burning point of steel, as it might be called. I have left pieces in the hot lead for hours, and it never injured them as I could see.

The steel letters were first dipped in the solution of flour, salt and water before mentioned, and were then immediately placed in the lead bath. The water



Base of Portable Forge



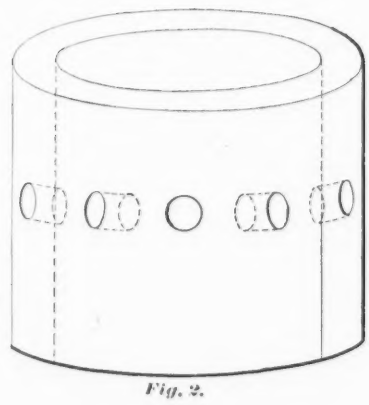


Fig. 2.

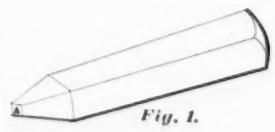


Fig. 1.

TEMPERING WITH A LEAD BATH.

coming in contact with the hot lead may cause a little explosion; but don't mind that; I have never been burnt from that cause. They are left there until they get hot enough to dip. In dipping I used to take a common tin pail and fill it with water and throw the steel letters in it; they would cool instantly.

When the pail was full I emptied the water out and then spread the steel letters on the floor to dry. Although I threw the hot pieces rather carelessly into the water, I never lost many by the cracking of the steel. After they were dry we brightened one side of them on the emery wheel, and afterwards laid them on a piece of sheet-iron placed over the gas stove, and drew the temper until they were a medium straw color. Then we dipped them once more, and after they had been oiled they were done.

Sketch No. 4 shows a handy pair of tongs or tweezers for handling small pieces; it is made of steel spring wire about $\frac{1}{8}''$ to $\frac{1}{4}''$ diameter, and the ends flattened down.

H. B. HUNGERFORD.

Making Arbors.

Editor American Machinist:

I note you desire to hear from your readers concerning mandrels or arbors, as to their being hardened. I advocate good cast-steel for arbors, and they should be left $\frac{1}{64}$ full, as dipping them into the salt water they are sure to spring out of truth; and grinding is the only way to make them true. Taper to foot .01″ centers cupped, and ends of arbor turned back, and each one having a flat spot milled only opposite each other for set-screw in dog. Soft or machine steel is not fit for arbors to my notion, as you can only case-harden them, and when the $\frac{1}{64}''$ is ground down to true the arbor the hard surface is lost. Heat them in a suitable furnace, using charcoal and animal bones. Cool them erect in salt water. ENG.

Mean Pressure in Cylinder.

Editor American Machinist:

I notice in Answer to Correspondents, 388, issue of August 27, a rule for finding the average pressure of steam when the initial pressure and number of expansions are given.

The method given below, though perhaps not new, may be found useful when no works on engineering are at hand, nor even a table of common logarithms accessible, and is simple, easy to be remembered, and nearly correct.

For illustration we will take the elements given in your answer to W. H. W., initial pressure, 61 pounds, cutting off at one-fourth of the stroke.

Construct a rectangle representing the cylinder, divide its length (in this case) into four parts, representing the number of expansions. See figure:

0		75.7
I	75.7	75.7
II	56 77	37.85
III	31.59	25.23+
IV	22.07	18 92+
	4)186.13	
	46 53+	
	16.2	
	30.33	

As in the example given the absolute initial pressure will be 61 + 14.7 = 75.7 pounds = the pressure with which the piston begins its stroke. Place this number at the top of the diagram. The pressure is the same when the piston is at $\frac{1}{4}$ stroke—the point of cut-off; consequently, place the same number opposite division I in diagram.

When the piston arrives at $\frac{1}{2}$ stroke the volume of the steam is doubled, and the pressure, according to a well-known law, is one-half of that at point of cut-off, viz., $\frac{1}{2} \times 75.7 = 37.85$, which place opposite division II.

When the piston reaches $\frac{3}{4}$ stroke the volume of the steam is trebled, and the pressure is but one-third of that at point of cut-off: $\frac{1}{3} \times 75.7 = 25.23+$, which place opposite division III.

So when the piston reaches the end of the stroke, the volume of the steam being quadrupled, the pressure is but one-fourth of that at cut-off: $\frac{1}{4}$ of 75.7 = 18.92+. Place this at the bottom of the diagram, opposite IV.

Now we have a diagram showing the pressures of the steam at five points of the stroke, and it remains to average it for the whole stroke.

The average pressure for space 0 — I is, of course, 75.7; that of space I — II is one-half of the sum of 75.7 + 35.85 = 56.77+; space II — III = one half of sum of 37.85 + 25.23 = 31.59; space III — IV = one-half of sum of 25.23 + 18.92 = 22.07+. Adding together the average pressures of the four spaces, and dividing by 4, we have 46.52 as the average pressure for the whole stroke, from which deduct back pressure for non-condensing engine, as in example given 1.5 + 14.7 = 16.2, leaving 46.53 — 16.2 = 30.33 for the effective average pressure.

This result is slightly in excess of that obtained by hyperbolic logarithms, owing to the few divisions made in the diagram. By multiplying the divisions a closer approximation to the true average may be made.

GEO. E. REID.

Stresses in Fly Wheels.

Editor American Machinist:

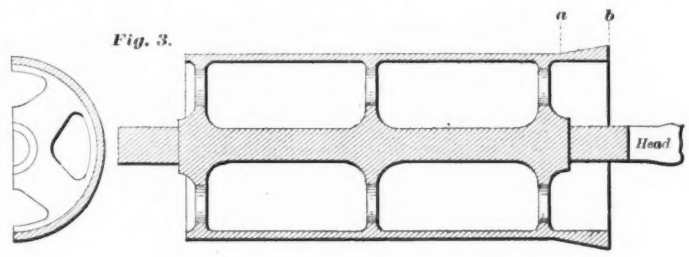
I quite agree with your correspondent, Mr. B. Erlin, that Prof. Joseph Torrey has not treated this portion of his subject in the simplest manner possible. As Mr. Erlin points out in your issue for August 20, the expression $S = .096\ V^2$, in which S = stress per square inch in rim, and V the velocity in feet per second, presents the matter in a much more convenient form, and this equation, or the approximate one, $S = V^2 \times .1$, is now very generally used. An expression of this kind, however, is not quite as simple as it appears at first sight. Take, for instance, the example given by your correspondent. Find the stress per square inch in the rim of a fly wheel 14 feet in diameter, and making 225 revolutions per minute.

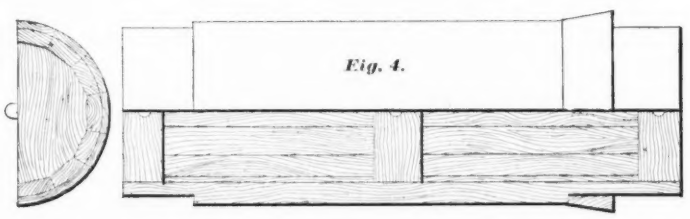
We have $S = \left(\frac{14 \times 3.1416 \times 225}{60}\right)^2 \times .096$ as the expression, giving the stress per square inch in the rim. Of course the matter is simplified considerably if one has a table of circumferences at hand; but otherwise the prospect of working out this *simple* expression is not particularly inviting. It is evident, however (although the fact appears to have escaped notice), that the equation can be readily changed into $S = (14 \times 225)^2 \times .00026$, an expression which I venture to think is much more convenient than the preceding. This expression, moreover, has the advantage of being more readily remembered, as the figures in the constant are at once suggested by the weight of a cubic inch of cast-iron.

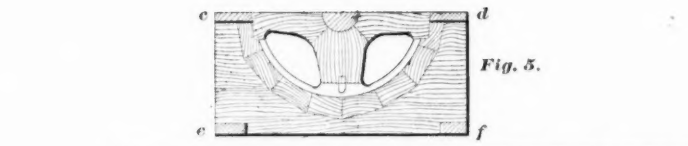
We have then to find the stress per square inch in the rim of a fly wheel. Rule: Multiply the diameter of the wheel in feet by the number of revolutions per minute, square the product and multiply by .00026; or in symbols $S = (D\ N)^2 \times .00026$, in which S denotes stress per square inch; D diameter in feet, and N the number of revolutions per minute.

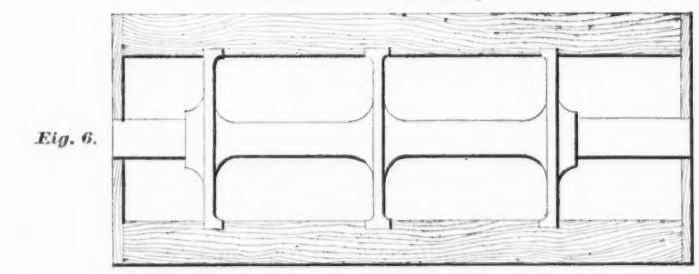
I may also point out that if n = number of revolutions per *second*, then $S = (Dn)^2$ approximately. C. N. PICKWORTH.

Manchester, Eng., Aug. 27.









Printing-Press Cylinders.

Two new gunboats were recently contracted for by the British Admiralty. These two boats—of which eighteen are to be built in all—are to be 230 ft. in length, 27 ft. in breadth, and are to have a displacement of 810 tons. They are to be fitted with triple-expansion engines of 3,500 horse-power under forced draught, and will be armed with two 4.7 in. and four 3-pounder quick-firing guns, together with five tubes for discharging torpedoes. Twelve of these boats will be built at the government works, and six by private firms.

The New York Central Railroad passes through the region of Sleepy Hollow, and the Catskill Mountains are just across the Hudson, so it is not surprising that slow-going travelers sometimes happen on the Central. A traveler boarded a train last month, however, who slightly surprised the conductor by handing in a stop-over check which was given to him thirty-four years ago. The conductor demurred to accepting the check, but the passenger insisted that his fare was paid through to Rochester, and that the stop-over check was evidence of that fact, and that the company was bound to honor it. The argument seemed to be sound, and the conductor took the "relic," and the passenger settled back in his seat to enjoy the ride that had been due him more than a generation. We regret that we have been unable to find out what kept the man waiting over so long.—*National Car and Locomotive Builder.*

Charles H. Cramp, of the famous Philadelphia shipbuilding firm, who has spent three weeks visiting the great naval yards of England, gave a dinner last week to the officers of the Admiralty, who afforded facilities for inspection. In discussing the results of his observations Mr. Cramp said there is no money wasted on fancy work in the British war vessels. Everything not absolutely necessary is excluded from the outfit and equipment of these ships. The constructors know what they want and do not bother with doubtful possibilities, as we do in America. There is a good deal of difference in the cost of warships here and at home. The excessive cost of our ships is altogether due to superfluities in the way of outfit and equipment, and the severe exactions and useless inspection of the quality of materials. As between America and England there is very little difference in the cost of merchant marine vessels, such as the Inman and White Star lines, but the naval architect in England is far ahead of America and every other nation in the world.—*Philadelphia Maritime Journal.*

Recently there was a race on Newark Bay between a naphtha launch and a steam launch. The naphtha launch won by a trifle, and, while this proves nothing in particular, either for or against naphtha *vs.* steam, it is quite a cause for rejoicing amongst the owners of naphtha launches.

The Exposition Directory has taken action under which adequate insurance will be placed upon all persons and property for which it can be held liable during the Fair. It is the intention to place an insurance of something like $300,000,000 on the exhibits.

Pattern Making.

BY P. S. DINGEY.

PRINTING PRESS CYLINDERS.

Some printing press cylinders have the ends bored out, and a short shaft pressed into each end, while others are made with the shaft and cylinder cast in one. Fig. 3 is a section and end view of one of the latter.

A great deal of trouble is often experienced in getting perfect castings of these cylinders, and to insure good castings they are cast on end in dry sand, or at least they should be; but in spite of all the preventives used against blow-holes, dirt, etc., a cylinder will sometimes show defects when the first cut is being taken off in the lathe.

Though cast on end, the cylinder is molded on its side, so that the pattern is made in halves in the ordinary way, as shown in Fig. 4. As an extra precaution against defects, an additional piece five or six inches long is cast on the end, as shown in Fig. 3, from *a* to *b*. The pattern should therefore be made that much longer.

This extra length will receive the impurities of the metal which rise to the top when pouring. It is made thicker on the end, so that it shall form a head which will exert a pressure, thus helping to produce a clean and sound casting.

Figs. 5, 6 and 7 are three views of the core-box. The end view, Fig. 4, shows it to be built up with staves which are nailed to three cross-pieces *A*, *B*, *C*. The box is strengthened by running four strips *c*, *d*, *e*, *f*, lengthwise on top and bottom of box, fastening them to the cross-pieces.

Two of the arms in each set are let in about $\frac{1}{8}''$ on the inside, to keep them from being rammed out of place, but a dowel pin is put in the arm that goes in the bottom of box. This is a very plain and simple job in pattern making, and needs no further explanation.

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NEW YORK, SEPTEMBER 17, 1891.

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Mechanical Flight.

An article which is bound to attract a great deal of attention has been written by Prof. S. P. Langley, and is published in the September number of the *Century Magazine*. Its title is "The Possibility of Mechanical Flight," and Prof. Langley freely states his belief that we have now acquired the power, by means of recently constructed engines, for such flight, and that all that is now lacking is the skill to direct and control the power and flight—a skill which he thinks we shall soon acquire.

Positive declarations coming from a well-known scientist, secretary of the Smithsonian Institution, will carry weight with them, and will certainly be respected, pending full public demonstration and proof; and, thousands of persons, recognizing the transcendent importance to civilization of such a discovery, will accept this article as proof that the problem is practically solved.

We do not propose to dispute that this is so, and it is hardly fair, perhaps, to base any criticism upon an article written specially for popular reading, yet it seems proper to say that, so far as the article itself goes, there is nothing to show that Prof. Langley in his experiments has always kept fully in mind the important difference between force and power; in fact, the evidence offered by the article itself seems to point almost inevitably to the conclusion that this distinction has not been properly made, and if not, then the experiments do not show what Prof. Langley thinks they show.

It is to be presumed, of course, that Prof. Langley is entirely familiar with the difference between force and power, but nevertheless the article seems to show that this difference has been at times lost sight of.

The experiments were made with planes or sheets of brass, which, by means of mechanism not fully described, but driven by a ten horse-power engine, were driven, or rather pulled horizontally through the air at various speeds up to seventy miles an hour. Thousands of experiments were made during a period of four years, and he says:

"In one class of these trials the plane was attached to a dynamometer, which showed, in connection with a chronograph, the amount of power which made the air just support the plane, so that it neither rose nor fell, but soared along horizontally; while among the first results of observation was a demonstration of the important fact that it takes less power to sustain such a body in horizontal motion than when it is suspended over one place—a conclusion the very reverse of that formerly reached by physicists, who, not having tried the actual experiment, started from the plausible assumption that we must first see how much power it will take to keep the body suspended over one spot, and then add to that power something very much larger to find what it requires both to suspend it and to move it along.

"To mention a single experiment out of many bearing on this last point, a sheet of brass in the form of a plane was suspended from the horizontal arm by a spring balance, which, when all was at rest, was drawn out to a distance corresponding to the weight. As soon as the arm was put in movement, however, and horizontal motion began and increased, the spring (which now not only sustained the plane, but pulled it along,) *contracted* more and more instead of lengthening, showing that the pull diminished with each increment of speed and each corresponding diminution of the inclination. It is very interesting to see with what slight power the heavy metal, when in such rapid motion, can be made almost to float on the air, and one can be convinced by the evidence of the spring balance or the dynamometer, combined with the record of the speed, that (within the limits of the experiment) it requires less and less power to maintain this horizontal transport of the plane the faster it goes."

We see in the above quotation what appears to be a confusion of terms as to force, or pull, and power, and it is almost superfluous to call the attention of our readers to the fact that, if the chronograph was used in this experiment simply to show that increased speeds were accompanied by diminished pull on the balance, and this speed not taken into account in determining the *power* required, then the experiment does not show what Prof. Langley declares it does show. No power whatever is expended in simply holding up a brass sheet or any other weight by suspension from a structure having its foundation on the earth, and though the *pull* upon a spring balance diminishes with increasing speed, the *power* required to move it may be increased, for the simple reason that one of the components of power (motion) is increased. It does not seem possible that a plate can be driven through the air at seventy miles an hour with less power than at thirty-five miles, but Prof. Langley declares unequivocally that this has been demonstrated to be so. It will not, of course, be accepted as true, however, until full details of the experiments are given, and when this is done, some points which in the *Century* article seem decidedly obscure, if not directly contradictory, may be explained.

The general results of the experiments are stated in what is declared to be carefully chosen language, as follows:

"If in such aerial motion there be given a plane of fixed size and weight, inclined at such angles and moved forward at such speeds that it shall always be just sustained in horizontal flight, then the more the speed is increased the less will be the power required to support and advance it, so that there will be an increasing economy of power with each higher speed, up to some remote limit not yet attained in experiment."

It is further stated that one horse-power "could transport and sustain in such horizontal flight over two hundred pounds weight of loaded planes at the rate of fifty miles an hour."

Basing his statement upon the fact that engines have recently been constructed to weigh considerably less than twenty pounds to the horse power, everything, including fuel for a short flight, included, and that less than twenty pounds of plates are needed to support this weight during flight, while two hundred pounds per horse-power can be carried, there remains a considerable margin (160 pounds) which can probably be carried.

The Tennessee Convicts.

The trouble in Tennessee over the attempt to put convicts at work in the mines in competition with the free miners continues to agitate the State, and upon the assembling of the State legislature to devise means of getting over the difficulty, some of the members seemed more disposed to impugn each other's motives, and bruise each other's noses, than to do anything else more useful. It is beginning to be generally recognized that putting the convicts to work in the mines, against the resistance of the citizen miners, is likely to prove a pretty big undertaking.

The fact is that when large numbers of men openly, without disguise or concealment, stand in broad daylight with arms, determined to resist a given action upon the part of the authorities, it can be depended upon that they sincerely think they have a good reason for so doing, and that they are backed by a considerable amount of public opinion. The natural difficulty of overcoming such resistance is greatly increased when the authorities fight to maintain a system which is as thoroughly disreputable and disgraceful as that of farming out convict labor as practiced in Tennessee and some other States has been proven to be. It will be a sad day for America when any considerable body of its citizens will tamely submit to having their chosen avocation invaded by bodies of criminals hired out to contractors.

Machinists at the Brooklyn Navy Yard.

The new civil service rules put in force at the Brooklyn Navy Yard seem to be working very satisfactorily, and it is now stoutly maintained that no "pull," however strong it may be, will do the least good in securing a position for any one, though it is easy for competent men to get employment there just now, for the reason that men of that kind are needed there to the number of about 100—among them 30 machinists. The hours of work are from seven to five, and the pay is based upon the best average pay in private shops. At present applicants must apply in person at the employment office, and will be examined in due time, the examination being of such nature that any good, competent mechanic can readily pass it. Upon passing this examination the applicant is put to work the next day, and for three weeks is on probation, during which time he must, in order to retain his position, prove in the shop that he is a competent workman. Of course, men who have previously worked on marine work will have the advantage of those who are unacquainted with it

The Machinery Trade.

There are evidences that the unusually good crops here, combined with an uncommon scarcity of food crops abroad, is having its effect in restoring the confidence necessary for the initiation of new business and manufacturing enterprises, and in some lines of the machine trade there has been an improvement within the past few weeks. One dealer in machine tools in this city says that the past two weeks have been the best in his experience, and that the prospect for business was never better for him.

While this does not fairly represent the general condition of the trade, it is still evident that the conditions mentioned above must eventually produce their legitimate effect, and this is a good time to prepare for business.

Literary Notes.

A new candidate for the favor of the reading public appears on our exchange table, and is called *The Chicago Clay Journal*. As its name indicates, it is a journal devoted to manufactures of clay, such as the brick-making and pottery industries, and is filled with articles of interest to those connected with such industries. It is a bright and very creditable journal. Amongst the "Principles" of the new journal we notice the following as number seven: "It will be a leading authority in scientific and practical researches."

This may be said to be a prophecy, the fulfillment of which will depend somewhat upon the appreciation of the clay-working public, as well as upon the efforts of the ambitious editor and proprietor. However, it is well to aim high.

MANUAL OF THE RAILROADS OF THE UNITED STATES FOR 1891, showing their Route and Mileage; Stocks, Bonds, Debts, Cost, Traffic, Earnings, Expenses and Dividends; their Organizations, Directors, Officers, etc. By Henry V. Poor.

This is the twenty-fourth annual number of "Poor's Manual of Railroads," and in order to keep pace with the times, and with the development of the railroad system, it has been made considerably larger than the previous numbers, and contains about 200 pages more than the edition of 1889. Many new and important features have been introduced which tend to simplify matters, and at the same time enhance the value of its statements to the banker or railroad man. But it is questionable if among these improvements there has been any that possesses more real practical value to the student of railroad affairs than the new maps which have been added. The sectional maps hitherto and still presented in the Manual have possessed great value for their accuracy, but the new maps now introduced concentrate the eye at once upon the whole system, show all the chief cities and towns, and present the geographical and topographical features of the various sections of the country shown.

The introduction to the Manual presents this year the features of an elaborate summary of the financial conditions and operations of the railroads of the country in 1890, and during the decennial period just closed with the census year of 1890. From this we learn that the length of track laid up to December 31, 1890, is 166,817.14 miles, of which were completed up to the close of the fiscal years of the respective companies 163,420.34 miles; completed since the close of their fiscal years, 3,397.07 miles; net increase of mileage in the calendar year of 1890, 5,498.38 miles; net increase of mileage in the fiscal year 1890, 3,426.56 miles; miles of

railroad operated, 157,976.46; passengers carried, 520,439,082; tons of freight moved, 701,344,437; passenger earnings, $273,664,439; freight earnings, $740,374,844; other earnings, $72,000,924; total, $1,086,040,207; operating expenses, $744,373,838; net earnings, $341,666,369.

The publishers of the Manual now issue two supplementary volumes—one entitled "Poor's Directory of Railway Officials"; the other, "Poor's Hand-book of Investment Securities." These books may be obtained from H. V. & H. W. Poor, publishers, 70 Wall street, New York.

QUESTIONS AND ANSWERS.

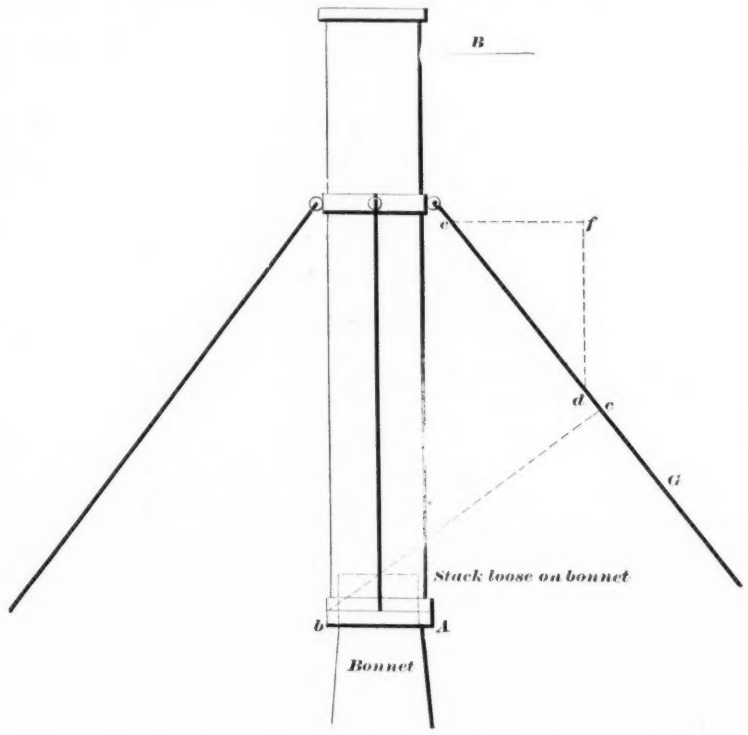
Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(410) J. W., Elizabethport, N. J., writes: Please inform me through your columns how the bearings in large steamers are lined up before the shaft is put in place. *A.*—Fine lines are stretched between given points, which are generally indicated on the drawing, and the bearings are set to these lines. Of course spirit levels or plumb lines cannot be used on board of a ship.

(411) F. T., New Philadelphia, Ohio, asks: Could you tell me where there is a mechanical school in which boys are taken to learn the machinist's trade, and where the boys receive small wages for the work they do? I would like to enter such a school, and if you know of one please give the address. Also, is there a good plumbing school? *A.*—We do not know of such schools. If you wish to learn the machinist's trade, and in the meantime receive small wages, the best school for you to enter will be a small machine shop, where a variety of first-class work is done. Similar remarks apply to the learning of a plumber's trade.

(412) "Critic," New York City, writes: Will you please give me a definition of the following terms? Monitor lathe, turret lathe, Fox lathe, screw machine, chucking machine. I want a definition that defines or differentiates one machine from the other if they are different, and a statement of which terms, if any, are synonymous. *A.*—The first two terms are synonymous, the preference being for "turret lathe," as it is more used and is more nearly descriptive of the machine to which it refers. A "turret lathe" we should define as a lathe made in the ordinary form of an engine or speed lathe, but provided with a revolving holder for tools, resembling a turret, and so arranged that by its revolution various tools may be presented to the work in succession. The turret may revolve automatically or by hand, and may be either on a sliding ram occupying the usual position of the foot-stock, or on the carriage, the latter arrangement being uncommon, however. The Fox lathe, which is used mainly for brass work, has for its main distinctive feature a sliding bar usually placed at the back, parallel with the shears, one end of this bar carrying a thread-chasing tool, while the other end, passing at the back of the head-stock, carries a piece of metal having threads cut on it to engage with the threads of a "hob," which is simply a threaded sleeve placed on the end of the lathe spindle, or upon a stud driven from it by gear wheels. This is used for cutting threads instead of the ordinary lead screw and carriage. The foot-stock is usually made in two parts connected by a cross-slide and traversing screw, so that tools placed in the foot-stock spindle may be traversed forward or back. The foot-stock spindle is usually square in cross section instead of round. A screw machine resembles a lathe in having a head-stock of the same general design, but has a hollow spindle through which the stock for screws in the form of bars or rods may be passed, and be held in a chuck which is placed on the end of the spindle. It has a turret mounted upon a slide, and usually revolving automatically with the motion of the slide There is also a cross-slide which can be clamped to the bed in any desired position, and carrying tools for cutting off the finished screw, rounding the corners, etc. Screw machines differ greatly in respect to their automatic movements, the simplest requiring all or nearly all the movements to be made by hand, while the most elaborate are entirely automatic in their action. All have reversing countershafts by which the die is run off after cutting the thread. Special forms of screw machines used in watch factories will be found described in our issue of January 29. A chucking machine may be either horizontal or vertical, and has a revolving chuck adapted to center and hold work such as wheels or pulleys while they are bored out by tools which may be held either on the foot-stock center, as in the simplest forms, or in a turret which may be advanced to the work by hand or by automatic feed motion. Sometimes, where the ordinary form of foot-stock is used, the spindle is provided with an automatic feed motion, and there is sometimes a small slide rest which may be turned to any desired angle, and be used for facing the ends of hubs or boring taper holes.

(413) H. B. H., Cleveland, O., writes: Enclosed you will find a sketch of a bonnet and stack for two boilers on which I desire some information. The stack is 65 feet high from the top of bonnet, and is 48 inches internal diameter; it is made of No. 10 and No. 12 iron, the lower half being No. 10 iron. The 65 feet portion of the stack weighs 4,600 pounds; the base rests on a collar marked *A*; this collar is riveted to bonnet by 10 rivets, ½ inch diameter. The stack is guyed by four guys of ⅝ inch wire



rope fastened to stack with a collar 20 feet from top; the guys are placed as usual on the ground. Now what I wish to know is, what is the shearing force exerted on the rivets in the collar? that is, the downward thrust of the stack, taking into consideration the weight of the stack and the wind pressure. I wish also to know the stress on the guys. Please tell me how to calculate the above stress by using the parallelogram of forces so that I can lay out the stress by scale. I have problems similar to the above coming up every day, and a rule of their solutions will be of help to me; I dislike to go by guess, but when it is necessary you cannot help yourself. *A.*—Problems of this kind can only be solved approximately, because it is impossible to compute exactly the forces which it has to resist. The pressure of the wind against the stack depends much upon the direction in which it blows, and even when the direction is known it is not always an easy matter to compute the pressure. We shall assume that pressure of the wind against the stack is 20 pounds per square foot. The outside diameter of the stack will be about 4.02 feet—we shall neglect the small fraction, and call it 4 feet. The pressure against the stack will be $65 \times 4 \times 20 = 5{,}200$ pounds, and the greatest stress on a guy will occur when the pressure against the stack acts parallel to the plane of the guy; under these conditions stress is transmitted to one guy only. In the case before us we shall assume that the pressure acts in the direction of the arrow *B*, so that the guy *G* only is subjected to a stress. The pressure tends to turn the stack about the point *b*; and the intensity of this action is measured by the moment of the pressure. The center of effort of the pressure is in the center of the stack, hence it acts with a leverage of 32.5 feet, and since the total pressure is 5,200 pounds, its moment will be $5{,}200 \times 32.5 = 169{,}000$ foot-pounds. The stack is prevented from turning about the point *b* by its weight, and the tension in the guy. The weight of the stack acts with a leverage of two feet, hence the moment of this weight will be $4{,}600 \times 2 = 9{,}200$ foot-pounds; subtracting this from the moment of the pressure we have $169{,}000 - 9{,}200 = 159{,}800$ foot-pounds, which must be resisted by the moment of the tension in the guy *G*, and consequently this moment must be equal to 159,800 foot-pounds. Through the point *b* draw a line *b c* perpendicular to the guy *G*. Let us assume that the line *b c* measures 35 feet; this length will be the leverage with which the tension in the guy acts, but the moment of this tension we have found to be equal to 159,800 foot-pounds, and since this is the product of the tension into its leverage or arm, we have

$$\frac{159{,}800}{35} = 4{,}565$$ pounds for the tension or stress in the guy *G*; the cross-sectional area of a ⅝-inch guy is equal to .11 of square inch, hence the stress is equivalent to

$$\frac{4{,}565}{.11} = 41{,}500$$ pounds per square inch. On the guy *G* lay off a distance *e d* with any convenient scale to represent 4,565 pounds; through *e* draw a horizontal line *e f*, and through *d* draw a vertical line *f d*, meeting *e f* in the point *f*; the line *f d* will represent the vertical pressure on the rivets due to the tension in the guy. Of course the line *f d* must be measured with the same scale as was used for laying off *e d*. Suppose, now, we find that by measuring *f d* it represents 3,600 pounds, then adding this to the weight of the stack we obtain the shearing stress on all the rivets through the collar *A*; that is, we have on the 10 rivets a shearing stress of $4{,}600 + 3{,}600 = 8{,}200$ pounds, or $\frac{8{,}200}{10} = 820$ pounds on one rivet. The cross sectional area of a ½-inch rivet is .19 of a square inch, hence the shearing stress per square inch of the rivets is $\frac{820}{.19} = 4{,}315$ pounds.

2. In regard to your question relating to the dynamo, write to manufacturers of dynamos; they are in a better position to advise you than we are.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

George B. Grant—Gear Wheels. See p. 20.

Link-Belting and Sprocket Wheels.

Send for Catalogue of Link-Belting.

Over 50,000,000 feet of Link-Belt in use.

Link-Belt Engineering Co., Philadelphia and N. Y.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

Drop Presses, Punches and Shears. Williams, White & Co., Moline, Ill., manufacturers.

Pattern and Brand Letters. A variety of sizes and styles. Heber Wells, 8 Spruce St., New York.

Davis Key-Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty St., N. Y.

Ice and Refrigerating Machines, 170 sold, and all successful. David Boyle, 521 Monroe St., Chicago, Ill.

"How to Keep Boilers Clean." A 96-page book mailed free by Jas. E. Hotchkiss, 112 Liberty St., N. Y.

Selden Packing for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Light Special Machinery and Tools to order. The Meriden Machine Tool Co., Meriden, Conn.

Universal and Plain Milling Machines. Pedrick & Ayer, Philadelphia, Pa.

Portable Cylinder Boring Machines. Pedrick & Ayer, Philadelphia, Pa.

Our Automatic Gear Cutting Machine will increase production 50%. The Superior Mach. Wks, Clev'd, O.

Boston Gear Works, Boston, Mass. Gear cutting of every description; noiseless gears a specialty.

$13.00 I. Dea L. Drawing Stands. The original. Send for postal. W. S. Rogers, Troy, N. Y.

One Star Hack Saw will cut steel a whole day without filing.

S. A. Smith, 23 So. Canal St., Chicago, Ill., agent for Appleton Mfg. Co.'s Emery Grinding Machinery.

Save small iron from foundry refuse. It pays. Use the Woodruff Pat. Separating Machine, Audubon Machine Works, New Haven, Conn.

For the latest improved Eccentric Hook, Connecting Rods and Stub Ends, address T. C. Dill Machine Company, Philadelphia, Pa.

"Twenty Years With the Indicator," by Thomas Pray, Jr. 10,100 sold. Price, $2.50. Order of bookseller; take no other.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker St., Philadelphia, Pa.

S. W. Card & Co., Mansfield, Mass., make everything in the line of Taps and Dies. S. A. Smith, 23 S. Canal St., Chicago, Western Agent.

For best Return Steam Traps, Pressure Regulators, Positive-Acting Pump Govs., Back-Pressure Valves, T. Kieley, 11 W. 13th St., N.Y. Send for des'n.

For the Latest Improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson St., Chicago, Ill.

Self-adjusting Hand-Screw for Pattern and Cabinet Makers, Wood Workers, etc. Sample by mail for 50 cents. Wm. H. Denney, Lancaster, Pa.

Upright Drills and Iron Planers, for immediate delivery; prices reasonable. J. E. Snyder, Worcester, Mass.

Our catalogue of books for engineers and machinists, mailed free to any address. Norman W. Henley & Co., 150 Nassau Street, New York.

Hyd. press, hyd. jacks, steam tables, accumulators, cutting and stamping dies for sheet metal, foot press, etc. S. Hartley, 245 N. J. R. R. Ave., Newark, N. J.

The Corliss Engine, by John T. Henthorn: A Manual especially adapted for every-day use. $1, free by mail. Egbert P. Watson & Son, 150 Nassau street, New York.

25″, 32″, 37″, 42″ — "Only Drill Press built on 'Ko-rekt' principles, even if they come from Jersey." Gould & Eberhardt, Newark, N. J.

Complete treatise on Screws and Screw-making, with clear and concise explanation of the methods; 95 illustrations. Price, $1.25 postpaid. E. & F. N. Spon, 12 Cortlandt Street, New York.

Do you wish to become an expert engineer Hawkins' Hand Book of Calculations will greatly aid you. 10 parts, 25 cents each, or in 1 volume, $2.50. Catalogue. Theo. Audel & Co., Publishers, 91 Liberty St., New York.

De Lamater Screw Propeller Wheel, made only by The Samuel L. Moore & Sons Co., Elizabethport, N. J., who have purchased from C. H. De Lamater & Co., New York, all their patterns, books of record, gauges, etc. Location and equipment well adapted for Heavy Steamship Repairs.

Club Rates.—If no one is getting up a club for the AMERICAN MACHINIST in your town or establishment, send for Circular of New Club Rates, and try it yourself. Address AMERICAN MACHINIST, 96 Fulton St., New York.

"Binders" for the AMERICAN MACHINIST. Two styles—the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. American Machinist Publishing Co., 96 Fulton St., New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2, postpaid. Published by John Wiley & Sons, 53 East Tenth Street, New York.

MANUFACTURES

Andrew Hume is about to start a foundry at Brewster, N. Y.

G. W. Goddard is the promoter of a rolling-mill at Berkley, Va.

The capacity of the Cordele (Ga.) electric light plant is to be doubled.

The Vulcan Iron Works will erect a new boiler shop at West Pittston, Pa.

There are probabilities of the establishment of a steel plant at Newport, Va.

W. F. Carter is reported as erecting an electric light plant at Galloway, Ark.

The Searcy (Ark.) Electric Light Works are being enlarged at a cost of $6,000.

A machine shop is to be established at Myers, Fla., by G. Forquer and others.

An electric light plant will be placed in the Stratton Ice Works at Pensacola, Fla.

C. J. Shelverton has organized a stock company to manufacture ice at Athens, Ga.

A new aluminum reduction plant may be established soon, in or near McKeesport, Pa.

The Richmond & Danville are to add a line of new machinery to its shops at Macon, Ga.

The Pittsburgh Locomotive Works will add a large machine shop to its works in Allegheny.

Wyman Flint & Son are to add new machinery to their paper-mill plant at Bellows Falls, Vt.

The Foster Machine Company, of Westfield, Mass., is to erect a new brick factory 50x300 feet.

The George B. Smith Foundry Company, Boston, Mass., will erect a new brick foundry 184x86 feet.

G. H. Sutherland, Gainesville, Fla., will put in machinery for washing and pulverizing phosphate.

Green & Manly are erecting new foundry and machine works at Dalton, Ga., according to report.

The Alabama Pipe Company will, it is reported, double the capacity of its pipe works at Bessemer, Ala.

The Greenfield Boiler Co. is a new concern located at Greenfield, Mass. I. N. Hopkins is treasurer.

Work on the new Enterprise Wire Works and steel rod-mill, at Joliet, Ill., is going rapidly forward.

The Montgomery (Ala.) Iron Works is being enlarged, to meet the increasing requirements of trade.

L. W. Smith, of Canton, Me., is enlarging his tannery, and will put in a new boiler, engine and other fittings.

Arrangements have, it is stated, been completed for the establishment of a plow factory at Bessemer, Ala.

George Forquer and C. T. Tooke will, it is stated, erect a machine shop and wood-working factory at Myers, Fla.

The York Manufacturing Company, of Saco, Me., is to add new automatic machinery to its finishing department.

The Salem Rolling-Mills Co., which is now erecting a rolling-mill at Salem, Va., will, it is stated, be reorganized.

A. B. Paterson and others, of Chicago, Ill., are to build new frictionless metal works, at Chattanooga, Tenn.

The Ætna Machine Company, of Hartford, Conn., has filed a certificate of increase of capital from $3,500 to $10,000.

The St. Louis Steel Foundry Company has resumed operations in a new and extensive plant at East St. Louis, Ill.

A $100,000 stock company is reported as being organized, for the purpose of erecting a cotton-mill at Columbiana, Ala.

The Armour Electric Light, Fuel and Power Company, Chicago, Ill., has been incorporated, with a capital of $5,000,000.

The Westcott Chuck Company, Oneida, N. Y., have issued catalogues of their chucks, in both French and German.

W. G. Lunsford, of Birmingham, has purchased property on which to erect a foundry and machine shop at Attalla, Ala.

The Baker Iron Company, Jasper, Tenn., will need full outfit of machinery for the manufacture of bar-iron and steel.

An addition 80x100 feet will be made to the sheet-mill of the Reading (Pa.) Iron Co. The mill has been closed for repairs.

The Polk County Mining Co., Ducktown, Tenn., is reported as to erect an electric light and power plant, at a cost of $10,000.

The sheet-mill of the Reading Iron Co., of Reading, Pa., has shut down for repairs. An addition, 80x100 feet, will be erected.

Brown & Benton, a new firm manufacturing brass goods and household novelties, have established a factory at Meriden, Conn.

The Jasper Iron Company has been organized at Jasper, Tenn., to manufacture field hardware, car forgings, bar-iron and steel.

The Excelsior Iron Works, of Chicago, Ill., will erect a five-story machine shop 74x91 feet. The structure will cost about $40,000.

Efforts are being made to organize a stock company to build a cotton-mill at Mooresville, N. C. J. W. Brown can give information.

Plans are being prepared by the American Tube and Iron Company to extend its Youngstown (O.) plant and increase the production.

According to report, Ohio capitalists will organize a stock company to erect an ice factory and cold storage plant in Pine Bluff, Ark.

The New Berne (N. C.) Ice Co. will, it is reported, put in new machinery to increase the daily capacity of its ice factory from 8 to 16 tons.

A project, it is stated, has been placed on foot to organize a company to manufacture iron by an electrical process at Chattanooga, Tenn.

The South Pittsburgh (Tenn.) Pipe Works has filed an amendment to its charter, increasing the capital stock from $1,000,000 to $2,000,000.

A Buena Vista (Va.) party is reported as endeavoring to organize a stock company for the purpose of erecting a paper-mill in Little Rock, Ark.

Another fertilizer and phosphate factory is reported as to be established at South Jacksonville, Fla. J. S. Smith, Jr., can give information.

The Ætna Iron Works at Norfolk, Va., recently destroyed by fire, will be rebuilt at once with greater facilities and more conveniences.

An electric lighting company is to be established at Portland, Conn. It will be capitalized at $60,000, of which $7,000 has already been subscribed.

The Griswold Knitting Machine Company, of New Haven, Conn., has been organized, for the purpose of manufacturing knitting and hosiery machinery.

The Beech Manufacturing Company, of Hartford, Conn., have decided to abandon their works in that city, and to remove their entire plant to Beacon Falls, Conn.

The stockholders of the Magnetic Iron Ore Co., at Blacksburg, S. C., have, it is stated, pledged $70,000 with which to build an iron furnace near Blacksburg.

The new electric light plant at the navy yard at Brooklyn, N. Y., is nearly ready for business. The dynamo-room is completed, and the wires are being strung.

The Baltimore & Ohio has purchased a large tract of land at Cumberland, Md., on which will be built shops, consolidating a number of the smaller shops on the system.

The Canadian Pacific Railway Company will erect a machine shop at Henderson, Me., for repairing the rolling stock of the road. An iron foundry is also contemplated.

C. Y. Mayo, Jr., and D. C. Hunt have purchased an interest in the Pollard (Ala.) Mills, and the plant will be put in operation. New machinery will probably be added.

The iron furnace lately reported as being built at Iron Gate, Va., by the A. K. Rarig Co., of Buena Vista, is, it is understood, being constructed for the Allegheny Iron Co.

The Cold Storage Transportation Company, of Chicago, Ill., has lately been organized at Chicago, for the purpose of operating refrigerator cars. The capital stock is $500,000.

H. C. Jernigan and A. D. Lipscomb are reported as having purchased the oil-mill and fertilizer factory of M. T. Trawick, at Opelika, Ala., for $15,000, and as to operate same.

The Carolina Midland Railroad Co. has, it is stated, selected site for its repair shops at Blackville, S. C. Mike Brown, vice-president, of Barnwell, can give information.

The Ross-Meehan Brake Shoe Foundry Company, Chattanooga, Tenn., has purchased the machinery of the old Globe Iron Works, at Sheffield, Ala., and will remove it to Chattanooga.

The Whitman Agricultural Company, at St. Louis, Mo., has secured the old Excelsior foundry adjoining its plant. This addition will increase the molding-room by at least a third.

A citizens' committee has been appointed by the mayor of West Superior, Wis., to arrange for building a highway viaduct one-quarter mile long over the railroad tracks at that place.

The Acushnet Mills, of New Bedford, Mass., are to erect a large new mill, and greatly increase their facilities for manufacturing. The new mill is to be 99x75 feet, and three stories high.

Anson Field, of Jericho, Vt., is reported as to move his pump works to Bedford City, Va., and a stock company as to be incorporated, with Anson Field, president, to operate same.

In connection with the Dennis & Roberts machine shop at Watkins, N. Y., E. H. Spicer intends to establish a molding plant. A cupola will be built, and castings of all kinds produced.

The King Manufacturing Company has been organized at Pine Bluff, Ark., with W. A. King as president; A. Brewster, vice-president, and J. M. Goza, secretary; capital stock $27,000.

F. H. Smith will prepare plans and estimates for the new bridge to be built across Jones' Falls at Lexington street, Baltimore, Md., by the city. The city commissioner can give particulars.

W. G. Lunsford, of Birmingham, Ala., has, it is reported, purchased property from the Attalla Iron and Steel Company, on which his company will erect an iron foundry and machine shop.

The Uncasville Mills, of Norwich, Conn., have decided to put in an electric plant for lighting their mill, and the Sibley Machine Company will make the shafting and pulleys to run the dynamos.

The Callaway County Hardware Company, of Fulton, Mo., has been incorporated, with a capital of $15,000. Incorporators: S. E. Fisher, B. B. Muir, C. H. Bauer, W. A. Fisher and D. W. Whanger.

An effort is being made by C. A. Corser and other Holyoke (Mass.) capitalists to have the Emerson steam coupling plant located in that city. Boston parties own a controlling interest in the device.

The Freeholders of Morris County, N. J., have agreed to build a new iron bridge with 44 feet span and 16 feet roadway across the Rockaway River at Port Oram. The contract has not yet been awarded.

Justus Roe & Sons, 52 Broadway, New York, have issued a circular and price list of metallic tape measures (steel and aluminum), also of various other appliances used by engineers, surveyors and others.

The St. Joseph Bridge and Boiler Company, of St. Joseph, Mo., are making preparations for the removal of their entire plant to Pueblo, Col. They employ 150 men, and their monthly pay-roll amounts to $15,000.

It is reported that a syndicate has been organized by London, Glasgow and New York capitalists, to build tin-plate-mills at Embreeville, Tenn.—the new town which is being built by the Embreeville Iron and Freehold Co.

Mr. George Hibsch, who has had many years experience in the foundry business, has established a foundry at No. 4½ Plain street, Albany, N. Y., where he will devote special attention to making brass and composition castings.

The National Malleable Iron Castings Company has purchased a 16-acre tract of land at the junction of the Illinois Central and Belt Railways, at Chicago, as a site for the erection of a plant which will give employment to 600 men.

The Proctor Steel Company will erect a steel plant at Johnson City, Tenn., to cost about $400,000, and have a capacity of from 100 to 150 tons daily. This is the only company in America using the Russian steel-making process.

The stockholders of the Elliott's Knob Iron Company met at Staunton, Va., recently; F. F. Cinioth, of New York, was elected president; F. G. Frick, of Pittsburgh, vice-president; and H. M. Wegner, of Staunton, secretary and treasurer.

The Henderson Light and Power Co., Henderson, N. C., lately organized to operate the electric light plant of the Henderson Electric and Gas Light Co., which it had recently purchased, has been incorporated, with a capital stock of $10,000.

The St. Louis Steel Foundry Company, whose works in East St. Louis, Ill., were destroyed by fire some six months ago, has completed a new and more commodious structure, and resumed operations on a much larger scale than before.

J. W. Morrison & Co., brass founders, of Youngstown, O., are increasing the capacity of their plant, caused by a large volume of orders. Samuel T. Luce, of Boston, has been admitted to the firm, and its business will be largely extended.

The Globe Iron Works Company, of Cleveland, O., has drawn plans for a 3,000-ton Mastlers steel tow barge. The boat is to be constructed entirely of steel, with the water bottom and collision bulkheads, as used in the best class of tonnage.

The Columbia Supply Company has filed articles of incorporation with the Secretary of State at Springfield, Ill., with C. D. Leach, C. A. Cox and John Francis as incorporators, to manufacture railroad supplies. The capital stock is $300,000.

The new butt-weld tube department now being added to the plant of the Riverside Iron Works, at Wheeling, W. Va., will be ready for operation in about two weeks. The nail factory of this firm, which is second to the largest in the world, remains idle.

The Hercules Foundry Company, incorporated in Massachusetts with A. L. Rand president, and O. B. Cole treasurer, has lately purchased and will complete the iron foundry of the Pike Manufacturing Company, in course of erection at Pell City, Ala.

In our issue of Aug. 27 we referred to a rumor that W. P. Thompson and J. R. Williams were to start a machine shop at Opelika, Ala. The item should have read: T. W. Thompson and J. R. Williams are erecting a machine and boiler shop at Opelika, Ala.

An addition is being made to the Phœnix Roll Works of Seman, Sleeth & Black, which will give to the machine shop increased space amounting to about 4,800 feet. New machinery will be added when the building is finished. A new tubular boiler also is being added.

The Central Car Repair and Manufacturing Company, which recently took possession of the Whitely Reaper Works, at Springfield, O., has a number of strong railroad men interested, and has a capital of $500,000. It will be several weeks before the works will be in operation.

The Vulcan Iron Works, located at New Britain, Conn., and owned by the Bridgeport Malleable Iron Company, are to be enlarged by the erection of two new buildings 70x227 and 47x106 feet respectively; they will be only one story high, but will have every modern appliance.

H. Lloyd Sons Co., proprietors of the Kensington Iron Works at Pittsburgh, have applied for a charter for a corporation to be known as the H. Lloyd Sons Company. The object of making application for the charter is to change the firm from a partnership to a corporation.

The Snow Steam Pump Works, Buffalo, N. Y., has filled an order for a compound duplex pump for a German firm. The works of the Snow Company have been in operation less than a year, and an order for a large pump from Germany will undoubtedly be encouraging.

The Delaware, Lackawanna & Western is erecting a new building at Hoboken, N. J., for the manufacture of Pintsch gas for the lighting of its passenger cars. The Chicago, St. Paul, Minneapolis & Omaha road has a similar plant now in course of erection at Minneapolis.

The Duquesne (Pa.) Tube Company's $90,000 addition to its pipe-mill has been completed. This department will employ 200 additional men, and as soon as these men are set to work the company will begin the erection of a large butt weld mill. In the future this firm will make its own gas from coal, having just completed a large plant.

The Rolled Steel Carriage Wheel Company, whose plant is being erected at Kensington, Pa., will probably be ready for operations by October 1st. The company is extending its work to carriage and wagon wheels of all descriptions, and also tubing for boilers' and plumbers' purposes.

San Diego, Cal., is to have an iron and steel plant, the ore coming from Bernardino County, 100 miles distant. Crude petroleum will be the fuel used. Dr. Charles J. Eames, of New York, is the leading promoter of the enterprise. The city of San Diego has raised $200,000 as a subsidy for the plant.

There is water-works agitation in Davenport, Ia.; Pueblo, Colo.; Hartford, Conn.; Blissfield, Mich.; La Crosse, Wis.; New Britain, Conn.; Louisville, Ky.; Mount Pleasant, Ia.; Shelton, Wash.; Detroit, Minn.; Willoughby, O.; Walton, N. Y.; Border City, Mass.; Greencove Springs, Fla.; Grafton, W. Va.

The Extensible Car Step Company has been incorporated, with office at Kalamazoo, Mich., and capital stock of $100,000. The company will manufacture extensible car steps. The stockholders are: Hiram B. Peck, Kalamazoo; Milton E. Company, Hamilton; A. M. Granger and George S. Johnson, of Grand Rapids.

There is water-works agitation in Plaquemine, La.; Renovo, Pa.; Spokane, Wash.; Jackson, Mich.; Monroe, La.; Gonzales, Texas; Snohomish City, Wash.; Berkeley, Cal.; Hackensack, N. J.; Moline, Ill.; Kansas City, Mo; Milton, Wash.; Shelton, Conn.; Le Sueur, Minn.

Ground has been broken for the new works of the Wilkes Rolling-mill Company, of Sharon, Pa. Two buildings will be erected, one 60x64 for the engine and rolls, and the other 36x160 for the puddling department. Some of the machinery is now on the ground, and is expected will be in operation in three or four months.

The Ludlow Valve Manufacturing Company, with $700,000 capital stock, was incorporated in Essex County, New Jersey, recently. The incorporators are Max Nathan, George H. Stover and David Colman, of this city; John T. Christy, of Troy, and F. W. Wheeler, of Montclair. The concern will manufacture valves and hydrants in Montclair.

A practical paper manufacturer of Buena Vista, Va., has offered to put $5,000 into a paper-mill at Little Rock, Ark., if a stock company could be organized at that place. He believes that the cotton-seed hulls, cotton waste and cottonwood trees so abundant in that region could be utilized to fine advantage in the manufacture of a good grade of news paper.

It is stated that the Baldwin Locomotive Works at Philadelphia will establish a test department of their own, which will be available to railroad companies desiring to have tests made of locomotives. This department will be equipped with the latest forms of apparatus, and will be in charge of competent men who are continuously employed in this class of work.

H. W. Ensign, of the Ensign Manufacturing Company, of Huntington, W. Va., will be the superintendent of the new freight car works to be built at Carteret, N. J., by the Canda Manufacturing Co. An order has been placed with Craig Ridgway & Son, of Coatesville, Pa., for the equipment of hydraulic cranes. The new works expect to be in operation in part by November 1.

Chas. P. Willard & Co., Chicago, Ill., have recently shipped to Burmah, India, a complete marine outfit for a small steamship, securing the contract against active competition of English builders. The *West Coast Lumberman*, from which we gather the facts, says: This is quite a victory for the American machinist—a fact which the AMERICAN MACHINIST is pleased to note.

The new shops of the Hanover Foundry and Machine Company, Hanover, Pa., will be: Foundry, 60x70 feet; machine shop, 90x140 feet. The capital is limited to $100,000, of which about half has been paid in. The company will manufacture engines, threshers, mill machinery (including paper-mills). The shops will be ready about the first of December, and will have connection with the P. R. R. and W. M. R. R.

The James Leffel & Co., Springfield, Ohio, and 110 Liberty street, New York, have issued a new catalogue of water-wheels. It is finely printed on excellent paper, and handsomely illustrated with cuts of water-wheels and plans for placing wheels both upon upright and horizontal shafts. Plans for measuring the flow of water are illustrated and described, and new tables are presented, along with information that will be valuable to those interested in water power.

Parallel Motions.

BY PROF. A. MACLAY.

(1) THE USE AND ABUSE OF THE NAME.

Point paths in mechanisms, or, as they may be more shortly termed, *mechanical loci*, form an interesting and useful branch of study that has not as yet received very much attention from writers of books on drawing. It is a study that may be made to give an excellent training in accurate drawing, and at the same time to impart some knowledge of the practical application of geometrical principles. There are three well-known classes of mechanism from which examples may be taken: (1) pantographs; (2) straight line motions, and (3) valve gears.

(1) The first includes those mechanisms in which two or more points move in similar paths; (2) the second class includes those in which one point is made to move either exactly or very approximately in a straight line, without the direct use of straight guides, and (3) the third class refers to arrangements in which the motion of slide valves depends upon the variable relative paths which can be given to one or more points in each gear. In the present papers it is proposed to give some examples of the first two classes combined, under the head of parallel motions, and the younger

readers of this journal may find it worth their while to draw them out. First a word or two as to the name. Rankine defines parallel motions as "*jointed combinations of link work, designed to guide the motion of the piston rod either exactly or approximately in a straight line, in order to avoid the friction which attends the use of straight guides.*" This appears to be the ancient and honorable use of the term, as we find it so used by Watt himself in his letter to his son, in November, 1808, in which he explains how the idea of "the construction, afterwards called the parallel motion" originated (1784) in his mind, winding up with the famous declaration: "Though I am not over anxious after fame, yet I am more proud of the parallel motion than of any other invention I have ever made." But as thus applied the name cannot be said to be in any way appropriate, since no two points in any of these so-called parallel motions move in parallel paths. If, however, we call them what they really are, viz., *straight line motions*, approximate or exact, then the term parallel motions may be very consistently applied to combinations in which two or more points are made to move in parallel straight lines, viz., to *pantographic applications of straight line motions*, and it is in this sense the above heading is used.

(2)—THE PANTOGRAPH.

There are two varieties of this mechanism; (1) the ordinary pantograph, and (2) the skew pantograph, or plagiograph. The geometrical principle upon which the ordinary pantograph is based is very simple. It depends upon the well-known properties of similar triangles.

Let $B\ D\ J\ H$, Fig. 1, be any parallelogram, and let $A\ K$ be any transversal* intersecting the sides $B\ H$, $D\ J$, and the sides $D\ B$, $H\ J$, produced at the four points A, E, G and K. Further, let the figure be supposed to represent links pin-jointed together at B, D, J and H. Then if one of these transversal points be made a fixed fulcrum or pivot, and the linkage be turned about that point, it will be found that the other three points on the *transversal* (1) *always lie on a straight line passing through the fulcrum*; (2) *always move in similar paths in the proportion of their distances from the fulcrum.* Thus, for example, suppose that we fix point A, and cause the point K to move in the straight line $K'\ K$, then it will be found that the intermediate points E and G on the straight line $A\ K$ will in like manner move in the straight lines $E'\ E$ and $G'\ G$ parallel to $K'\ K$. Also if any other parallel link be added, such as $C\ I$, the same will be true of the point F in which it is intersected by the transversal. F will move in the straight line $F'\ F$ parallel to $K'\ K$. Further, it will be found that the range of motion in each case is proportional to the radii $A\ E$, $A\ F$, $A\ G$ and $A\ K$ respectively.

For since by the nature of the construction supposed, opposite links must always remain parallel, then, by the principle of similar triangles, $A\ E$, $A\ F$ and $A\ G$ must continue in the same ratio as $A\ B$, $A\ C$ and $A\ D$. But the three latter lengths are fixed, *i. e.*, their ratio is constant. Therefore the ratio of the three former lengths is also invariable. And if $K\ L$ be drawn parallel to $J\ D$, and $A\ D$ be produced to meet it, the same thing must hold good for $A\ L$ and $A\ K$. Thus, $A\ E : A\ F : A\ G : A\ K :: A\ B : A\ C : A\ D : A\ L$ (1) Therefore the distance of any one of the four points E, F, G and K from the fulcrum A is always in the same ratio to that of any other point, in whatever position the linkage may be turned. Again, by exactly the same reasoning it can be shown that $B\ E : C\ F : D\ G : L\ K :: A\ B : A\ C : A\ D : A\ L$ (2) *i. e.*, that the ratio of the lengths $B\ E$, $C\ F$, etc., is also constant in all positions of the linkage. Therefore if the points A, E, F, G and K are on a straight line to begin with, they will remain on a straight line in all positions of the mechanism, and it has been shown that in all positions they preserve the same ratio of distance from the fulcrum. Therefore the paths described by them must be similar, and proportional to those distances.

This principle has had two important applications; (1) to the reduction or enlargement of drawings, and (2) to the duplication of straight line paths in mechanisms.

Fig. 2 shows a line diagram of the drawing instrument known as the pantograph. It consists of four links connected together so as to form a parallelogram. One intersection of a transversal is made a fixed point, and the relative motions of the other two are employed to enlarge or reduce drawings. The four links are permanently connected at two opposite joints of the parallelogram, but the other two joints are made easily disconnectable for varying the scale of the reproduction.

There are two ways of using the instrument. In the one, the two describing points

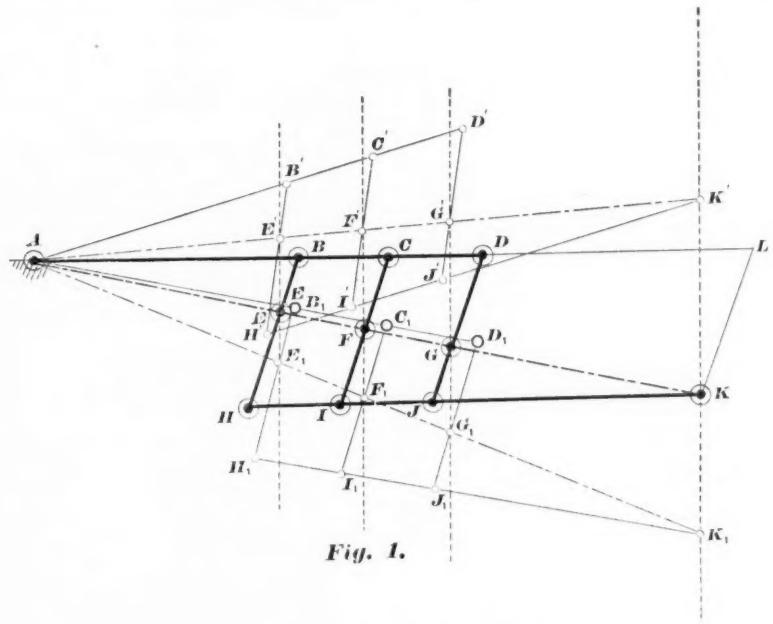


Fig. 1.

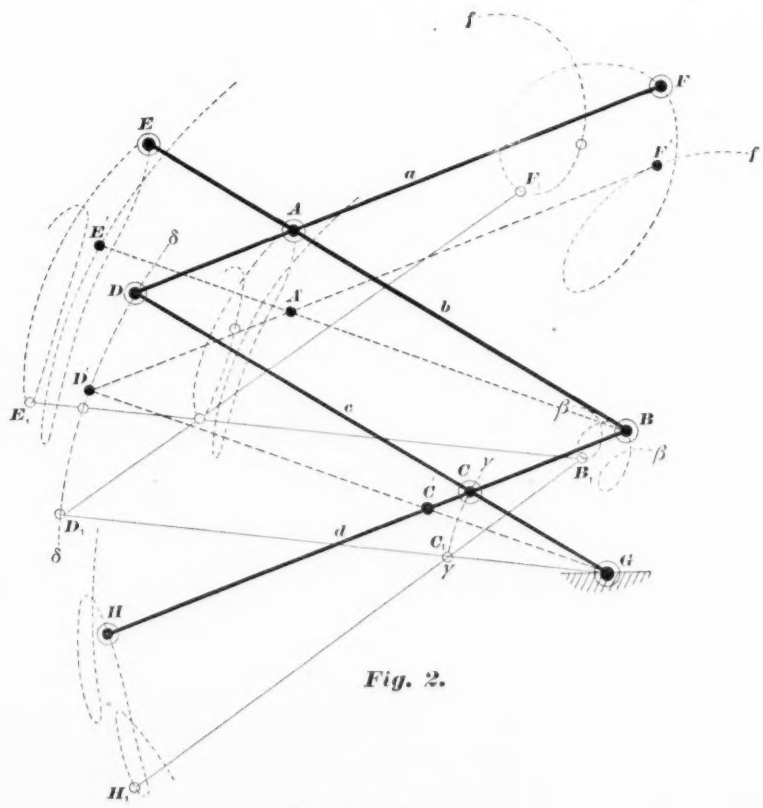


Fig. 2.

PARALLEL MOTIONS.

are on opposite sides of the fixed point or fulcrum joint, and in the other they are both on the same side. By the former arrangement the fulcrum may be fixed to the board between the drawing and the copy, but the copy is upside down relatively to the original. The other arrangement is as shown in Fig. 2, in which a, b, c and d are the four links jointed together at A, B, C and D. A line drawn through the hinge joint B, for example, intersects link a at F, and link c at G. Then if G be made a fixed point, the distances $G\ B$ and $G\ F$ will preserve a constant ratio throughout the entire range of movement of the instrument. If, therefore, pencils or tracing points be placed at B and F, and one of them be guided to follow the outline of any figure within the range of motion of the instrument, the other will copy or reproduce it in the proportion of their respective distances from the fulcrum point G. Thus if B be the guided point, F will enlarge the representation in the proportion $\frac{F\ G}{B\ G}$; on the other hand, if F be guided, B will reduce the representation in the proportion $\frac{B\ G}{F\ G}$.

To alter the scale of the representation, it is only necessary to disconnect joints A and C, and fix them anew in some different position, taking care that the distances $B\ C$ and $D\ F$ are in the proportion required, and that the parallelism of the links is strictly preserved. Thus, for example, suppose that in F's reproduction of B's movements the scale of the representation is to be altered from $\frac{F\ G}{B\ G}$ to $\frac{F'\ G}{B\ G}$, the change can be made by disconnecting joints A and C, and altering the position of pencil F, making $D'\ F' : B\ C' :: F'\ G : B\ G$ or $\frac{D'\ F'}{B\ C'} = \frac{F'\ G}{B\ G}$. The new setting of the instrument would now be as shown in heavy dotted lines, and F' would follow B in the required proportion; but the same alteration can be made without the inconvenience of having to change the position of the pencil F on the link a. Thus let $F\ D$ be a fixed length, and let the alteration of scale be as before, from $\frac{F\ G}{B\ G}$ to $\frac{F'\ G}{B\ G}$. Firstly, then, for joint C on link d we must have $F'\ G : B\ G :: D\ F : B\ C'$ or $B\ C' = \frac{B\ G \times D\ F}{F'\ G}$. Secondly, for joint A on link a, we have $D'\ A' = B\ C'$. Again, since $D\ G$ is a fixed length, we must alter joint A on link b, and joint C on link c. For the former we have $F'\ G : B\ G :: D\ G : B\ A'$ or $B\ A' = \frac{B\ G \times D\ G}{F'\ G}$. For the latter, viz., C on c, we have $D'\ C' = A'\ B$.

To enable such changes to be readily and accurately made, each link is graduated like a scale, and relative positions marked by the same numbers on all four links. To keep the links parallel to the surface of the paper and facilitate their movements on it, a roller is provided at D.

* Any line, straight or curved, which cuts a system of other lines.

Fast Mail Carrying.

Quite a remarkable feat in the way of fast traveling by land and water is related in the following account, which we take from a daily paper.

The mail from Yokohama via the "Empress of Japan," which reached Vancouver after a ten-days voyage across the Pacific, and which was sent on by special train over the Canadian Pacific and the New York Central & Hudson River Railroad, arrived in this city at 4.43 yesterday morning.

The steamer "City of New York," for which it was intended, was advertised to leave at 5 A. M. from her dock. It was thought then that the mail could not be put on the steamer in time, but the attempt was successfully made. The mail pouches were hustled into a big wagon and drawn to the steamer by four horses. If the "City of New York" has luck the mail will arrive in England on Sept. 9, and will be a record breaker from Japan.

The "Empress of Japan" left Yokohama on Aug. 19, and reached Vancouver on Aug. 29. The special train over the Canadian Pacific started immediately and arrived at Brockville at 9.40 on Tuesday morning, or in just three days and ten hours from the Pacific coast. Express trains take five days and eighteen hours to make the run, which is 2,859 miles. The New York Central people took the mail at Morristown, on the St. Lawrence River, and carried it over the Rome, Watertown & Ogdensburg Road to Utica, a distance of 123 miles, in 153 minutes. This fast run was made on a single-track road. The train stopped three times and slowed down twice in passing over bridges which were undergoing repairs. From Utica to Albany the distance is 94 67-100 miles, and the flier covered it in exactly ninety minutes. The train left Albany at 2.02 o'clock, and rolled into the Grand Central station at 4.43 A. M., having scurried over 143 miles of railroad in 141 minutes.

To this is to be added the further fact that the "City of New York" on this trip broke the record for the eastward passage, which she made in 5 days, 22 hours, 30 minutes, making the time of the mail from Yokohama and Liverpool, a distance of 15,000 miles, something under 20 days, or about 750 miles per day.

Exclusive Manufacturers.

We have received from the Pratt & Whitney Co., of Hartford, Conn., a letter containing the following statement of fact:

"In your issue of the 10th inst. we notice an article relating to the purchase of guns by the Chinese government, in which you speak of the Hotchkiss rapid-firing gun being made by the Pratt & Whitney Co. and Colt's Armory.

"We beg to say that we have the excluclusive right in U. S. A. for the manufacture of the Hotchkiss gun. The Colt's Armory does not and never did make the Hotchkiss gun."

A correspondent who gives us no address except the rather uncertain one of Brooklyn, asks us to name some party in Brooklyn who will give private instruction in drawing. While we do not personally know of such a party, we have no doubt but he could be found—a half dozen of him—if the proper means were taken. But we could hardly help our friend—if we tried never so hard, who has no other address than Brooklyn.

We have received a copy of the 1890-91 Catalogue of the Ohio State University, at Columbus. It affords evidence that good educational work is being done there, and that the school is prepared to do still better work in the future. It is announced that the terms of admission to the courses in engineering have been changed somewhat, a statement of the present conditions being given in the Catalogue.

Machinists' Supplies and Iron.

NEW YORK, September 12, 1891.

Iron—American Pig—Stocks are offering more freely, with an easier tendency. No important business is reported.

We quote: Standard Northern brands, No. 1 Foundry, $16.75 to $18; No. 2 is selling at $15.50 to $16.50, and Gray Forge at $13.90 to $15. Southern brands of good quality are obtainable at $16 to $17.50 for No. 1 Foundry; $15.75 to $16 for No. 2; and $14 to $14.50 for No. 3.

Scotch Pig—We quote Coltness at $23, and Eglington, $20.50.

Copper—Lake Copper is firmer, in sympathy with stronger advices from abroad, and holders' inside figure is strictly 12¾c., while some continue to ask 12¼c. There is more or less inquiry, but no business of importance. Casting copper is steady at 11¼c. to 11½c.; and Arizona Ingot is quiet at 12c. to 12¼c.

Lead—Holders of Pig Lead continue to ask 4.50c. to 4.55c., while buyers offer 4.40c. to 4.45c. without any prospect of business. The market remains quiet, and sellers are rather reserved in their offerings. It is claimed that 4.47½c. would buy.

Spelter—The market is quiet at 4.90c. to 4.95c. asked for shipments to New York. Consumers are feeling the market, preparatory to placing some contracts. Business has been declined at a shade under the price named for good brands.

Tin—The market is quiet, with no disposition to operate. Higher quotations abroad influenced a firmer feeling here, and the asking rates were 20.10c.

Antimony—Prices are lower, in sympathy with weaker advices from abroad at unchanged figures. We quote: Hallett's, 9¾c.; Cookson's, 12c.; and 10¼c. for L. X.

Lard—The market is steady at 56c. to 57c. for Prime City, according to holder and quantity. Western on spot is quoted at 55c.

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Steam engine designer, high speed & compound, desires perm't position; refs. Adrian, AM. MACH.

Wanted—Competent draftsman on printing machinery. Address Cylinder, Box 58, AM. MACHINIST.

Mechanical engineer wants a position as draftsman, or in any branch of mechanical or electrical engineering. Address Mechanical, AM. MACHINIST.

Wanted—A position for experimental, fine mechanical or small tool work in a machine shop. Address G. P. K., care AMERICAN MACHINIST.

Young mech. eng. (31) draftsman & designer, exp'd in engines, cranes, machine tools, also as traveling salesman, desires engagement. "Speed," AM. MACH.

Young man with some experience wants situation as assistant engineer; wages no object. Al. Brown, 462 Main St., Cambridgeport, Mass.

Wanted—A first-class machinist with executive ability, as foreman of a machine shop building gas engines. Address Box 59, AMERICAN MACHINIST.

Designer and draftsman wants position; has had experience in cranes, machine tools, steam engines and buildings; graduate of leading technical college, and has had shop exp. Box 54, AM. MACHINIST.

Wanted—A first-class foundry foreman on printing press and general work. A young man preferred. Address, giving age, past and present employers, W. H. M., Box 235, Boston, Mass.

Wanted—A thoroughly competent engineer, one who is capable of running engine and handling a large steam plant; must be able to furnish first-class reference. Address Box 55, AM. MACHINIST.

Wanted—A first-class mechanic, conversant with the construction, repairing and operation of locomotives in all details; applicants must be temperate, giving refs., and salary expected. Wm. Douglas, Gen'l Supt. M. & N. E. R. R., Manistee, Mich.

Mech. engineer with 12 yrs. practical experience, who has successfully filled important positions in large mfg. concerns, is open for engagement. Experienced in modern methods of manufacture, and in the handling of men. Box 60, AM. MACHINIST.

A good dr'fts'n and excellent designer, with consid'ble exp. in mak'g special tools, etc., also having exp. in the control of men, seeks change of position; good reasons given; refs. Box 57, AM. MACHINIST.

Position wanted by first-class mechanical draftsman, with good experience in steam and marine engine, ice and mining machinery, sugar refineries, steel works, designing of factories, and general engineering. H. S., AMERICAN MACHINIST.

Wanted—A position as supt. or foreman by a first-class mechanic; thoroughly understands model, die and tool making; has been connected with some of the finest work done in the country. Correspondence solicited, references exchanged. Address Box 51, AMERICAN MACHINIST.

Shall need by January next a draftsman, accustomed to latest practice in small tools for turret lathes, bolt cutters, and kindred machinery; one able to put such tool making on a manufacturing basis; a technical graduate preferred. Address, stating age, experience, and salary expected, Box 56, AMERICAN MACHINIST.

Wanted—At a machine shop near New York, employing about fifty men, a thoroughly competent foreman having immediate charge of men, who is willing to carry out ideas, methods and orders given him, in as thorough and conscientious manner as he would do if they originated with himself; one methodical in his habits, and thoroughly acquainted with, and capable of administering efficient shop discipline, to the end that the work turned out will be done skillfully and economically. A man with technical education or some training in technical school or its equivalent preferred; state age, experience, and salary required. A. B. C., AM. MACHINIST.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion.

Cheap 2d hd-lathes & planers. S. M. York, Clev'd, O.

Auto. Steam Flue Cleaners. Kelley Co., Erie, Pa.

Light and fine machinery to order; Foot Lathe Catalogue for stamp. E. O. Chase, Newark, N. J.

Best Bolt Header in the world for $50. Address C. H. Baush & Sons, Holyoke, Mass.

Wanted—Specialties to build for the Southern trade. Bluefield Iron Works, Bluefield, W. Va.

Wanted—Novelties to build. McNair Tool Company, Meadville, Pa.

Piping wrench patent for sale outright, or on royalty. Bruce Hough, W. Gardner, Mass.

Railroad accidents made nearly harmless; wants partner in patent. F. Taaffe, 120 Charles St., N. Y.

Special leather and cement for covering pulleys; no rivets required; local agents wanted. Crescent Mfg. Company, Cleveland, Ohio.

Fine Automatic Machy. Punch, Die & Screw Mach. Work Specialities. Send sample for low estimates. Novelty Mach. Works, Orange, N. J. P. O. Box 434.

For Sale Cheap or Exchange—Eleven right and left modern Patent Automatic Cut-off Engine Patterns & Drawings, from 10" to 20". B 9, AM. MACH

For Sale—Three 3-ton jib cranes, 20 feet height of mast, swing in space of 35 feet. Apply to The J. Morton Poole Company, Wilmington, Delaware.

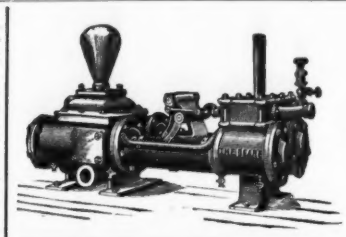
Wanted—Agents for the Machinists' Hand-book on lathe screw cutting, figuring speed, setting valves, etc., etc. Price 50 cts. Loetzer & Bynon, Sayre, Pa.

Wanted—Practical and original shop kinks for manufacturers' catalogue; will pay for all used. A. A. C., 42 Church Street, Cleveland, O.

Wanted—A good second-hand planer, size about 42 inches x 40 inches x 10 ft.; state condition, name of maker, and lowest price to F. Huetteman & Co., Detroit, Michigan.

Wanted—Engineers to write for catalogue of all the latest and most valuable mechanical, scientific and electrical books which are given free with each barrel of the Pittsburgh Boiler Scale Resolvent. Pittsburgh Boiler Scale Resolvent Co., Pittsb'gh, Pa.

A young mech. engineer, having good exp. in fine and also large work, drafting, designing, controlling men, and having a specialty of unusual value, would associate himself with a young man of good business exp. and qualifications, having capital to push the same after an inexpensive experiment gives satisfaction; reliable parties only desired, investigation made. Practical, AM. MACHINIST.



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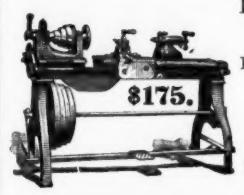

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Drill Presses, Shapers, Band, Circular and Scroll Saws. Machinists' Tools and Supplies. Lathes on trial. Catalogue mailed on application.
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Fine Taps, Dies, Reamers, Etc.
Lightning and Green River Screw Plates.
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Bolt Cutters, Hand and Power Drilling Machines, Punching Presses, Tire Benders, Tire Upsetters and Other Labor-saving Tools. Send for Price List
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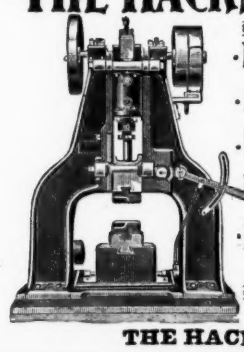
New York Agency, No. 126 Liberty Street.

THE HACKNEY POWER HAMMER

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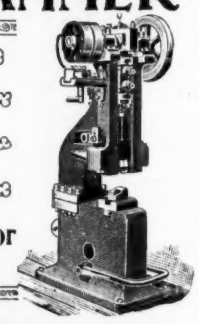
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All Kinds in Stock.
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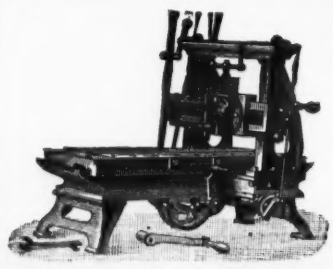
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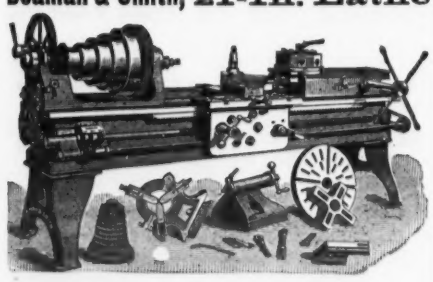

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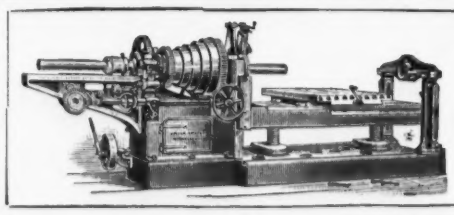
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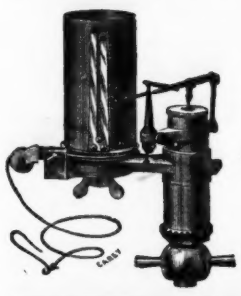

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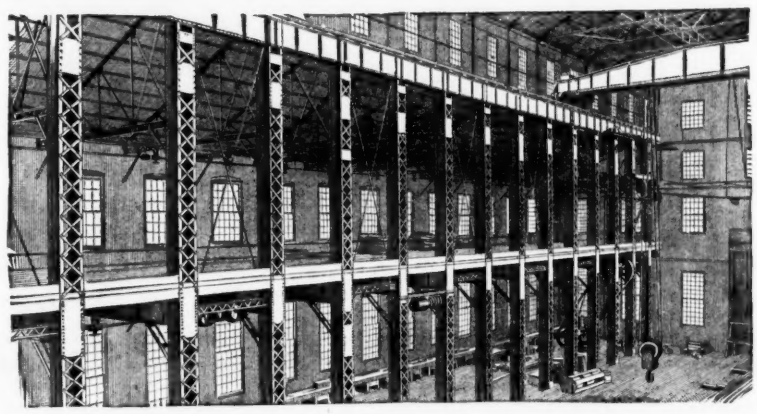

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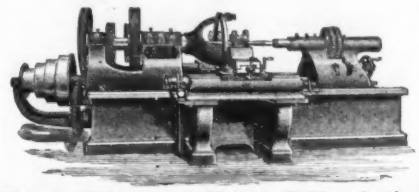

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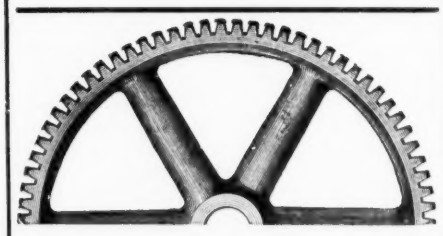

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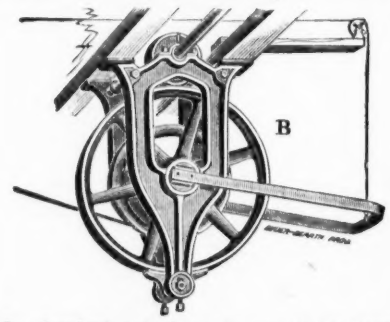

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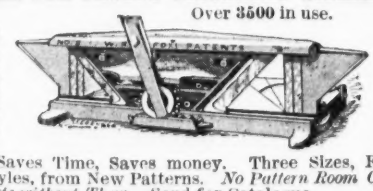

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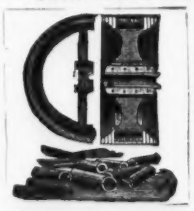

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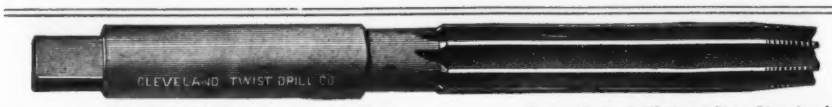

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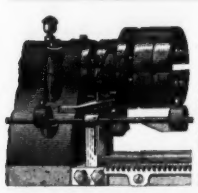

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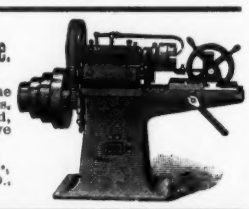

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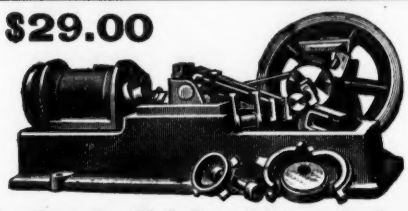

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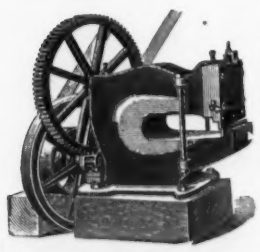

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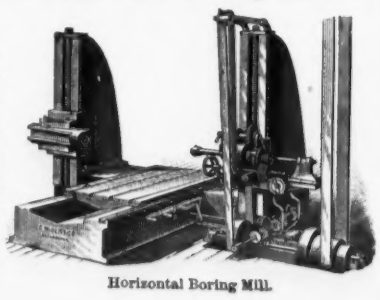

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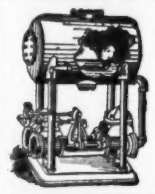

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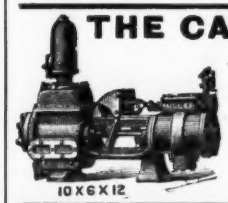

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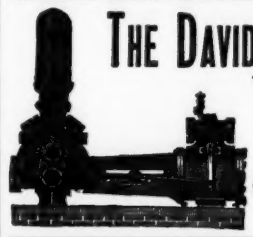

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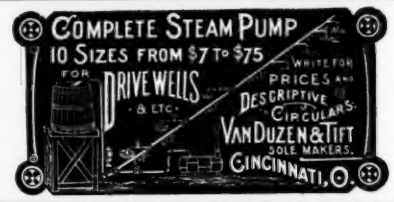
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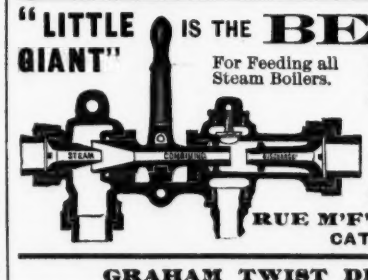

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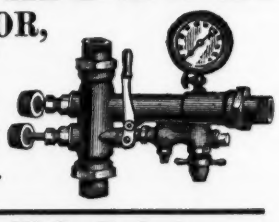

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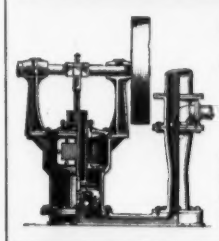

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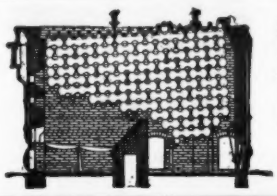

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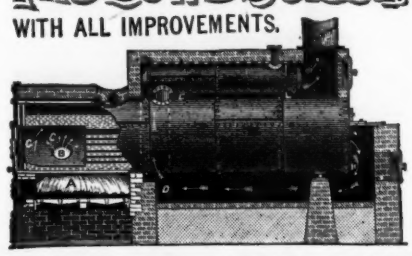

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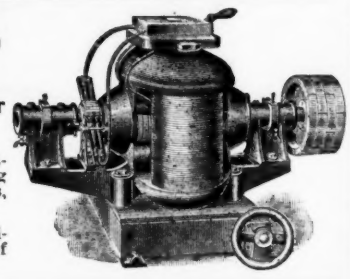

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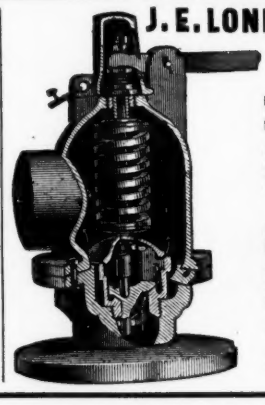

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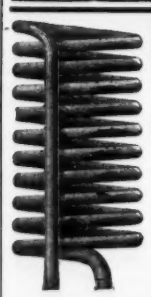

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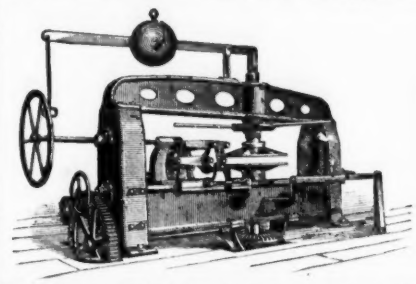

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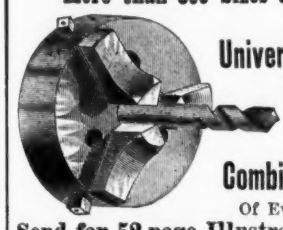

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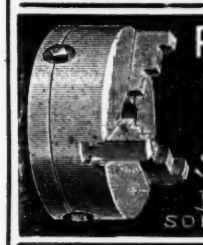

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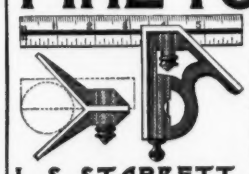

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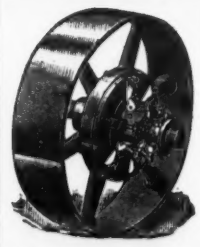

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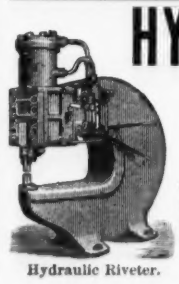
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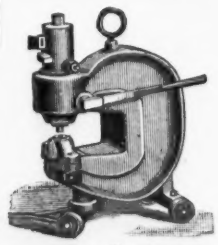
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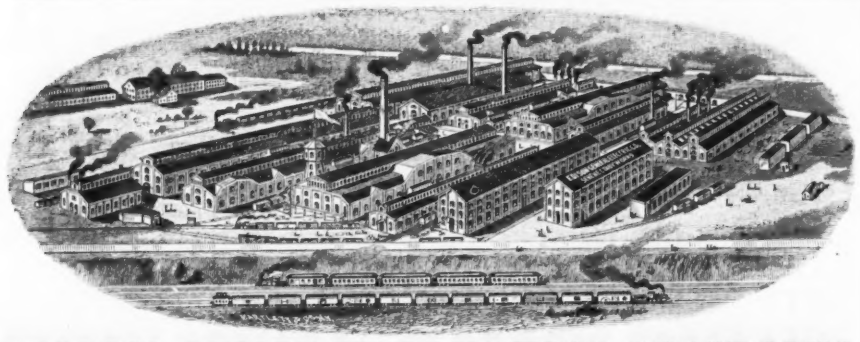

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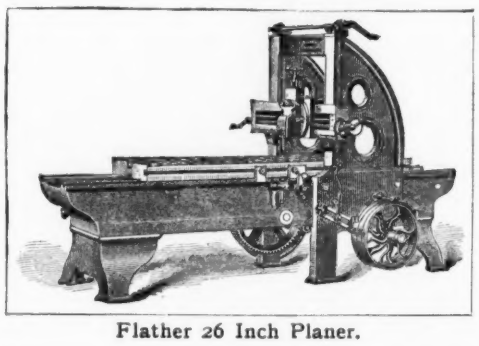

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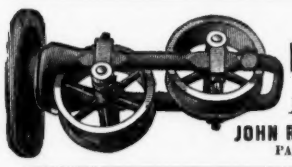

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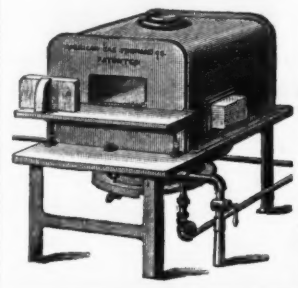

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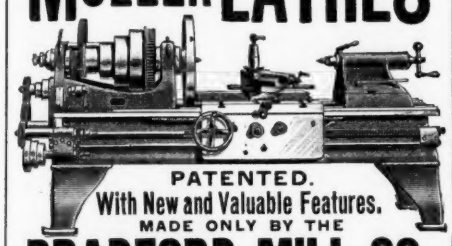

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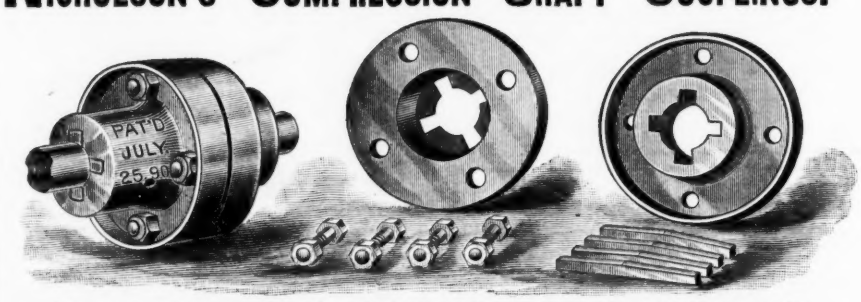

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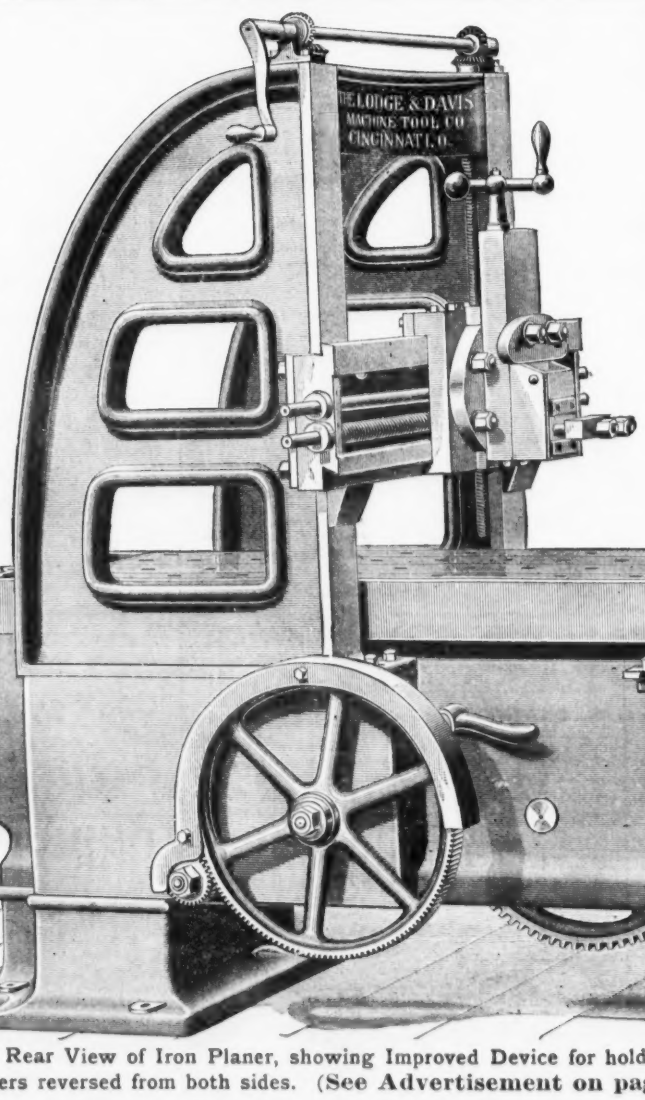

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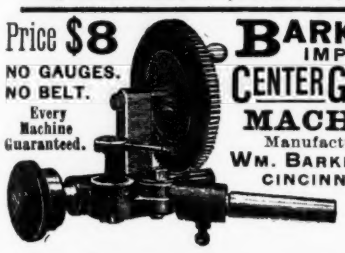

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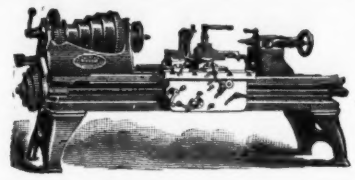

NEW HAVEN MANFG. CO.
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IRON-WORKING MACHINERY,
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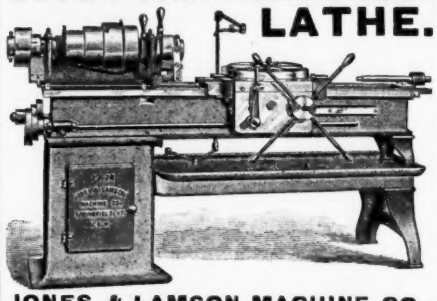
2 BY 24 TURN TABLE TURRET LATHE.



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L. W. POND MACHINE CO.
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IMPROVED PATENT IRON PLANERS A SPECIALTY.
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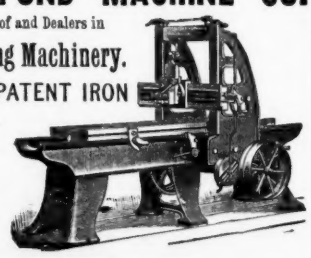

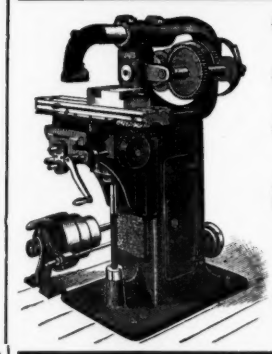

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Reamer Grinder
will grind all kinds of cutters and reamers up to 8" diam. without the use of special attachments.

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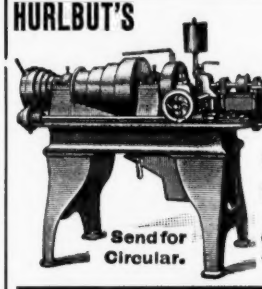

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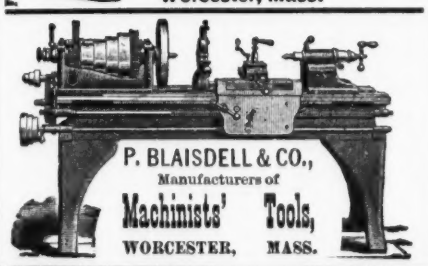

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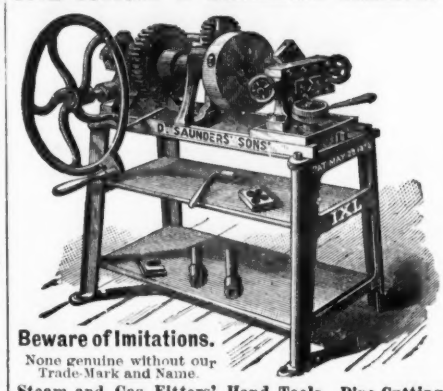

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Steam and Gas Fitters' Hand Tools. Pipe Cutting and Threading Machines for Pipe Mill use a specialty.
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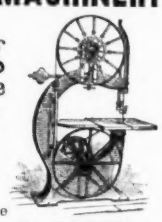

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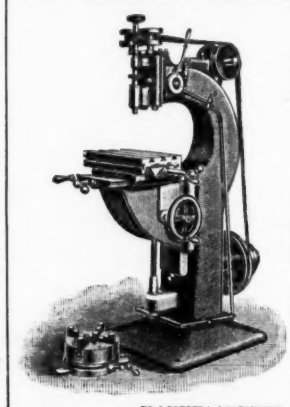

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Speeds from 240 to 10,000 revs.
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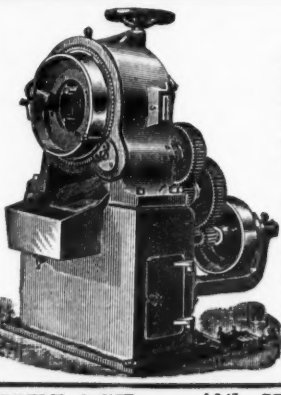

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FOR HAND OR POWER.
RATCHET DRILLS, RATCHET DIE STOCKS AND MALLEABLE IRON PIPE VISES.

NEW SHOP. AMPLE ROOM.
PERFECT EQUIPMENT. PERFECT LIGHT.
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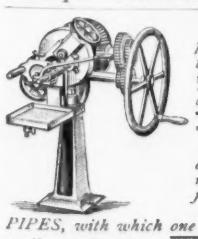

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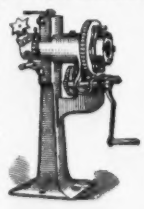

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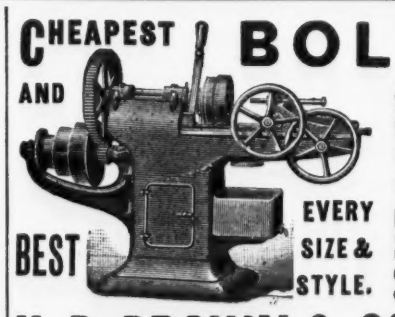

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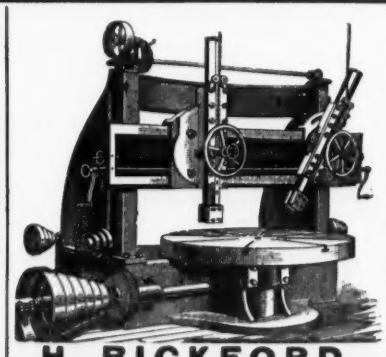

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OVER 300 SIZES.
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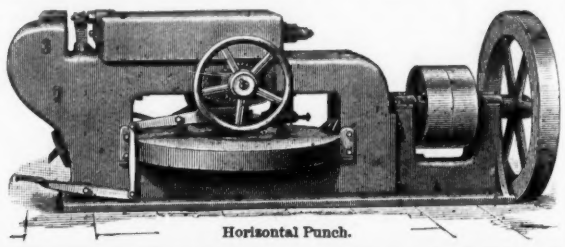
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For Finding and Correcting the Center of
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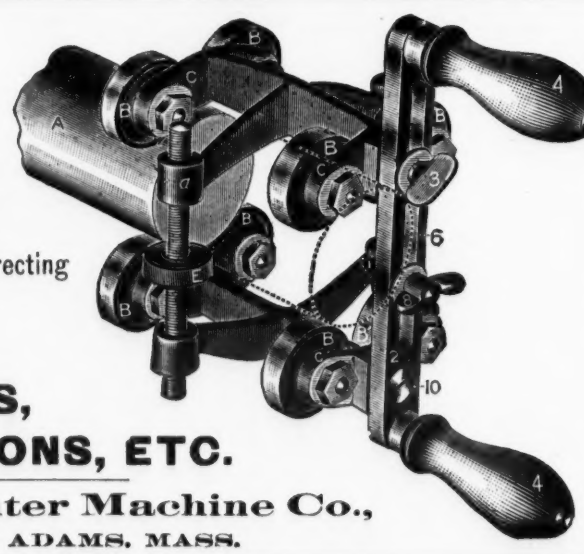

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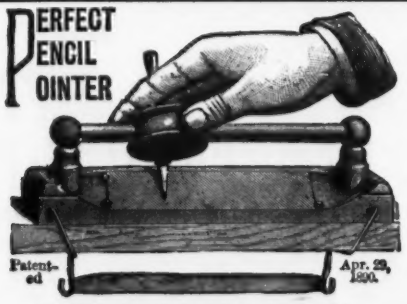

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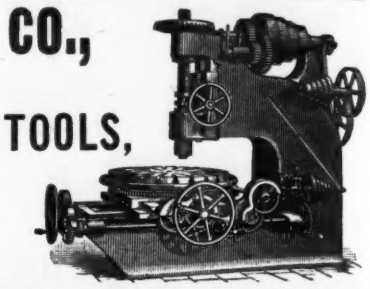

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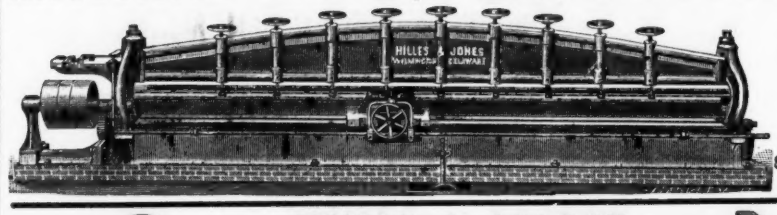

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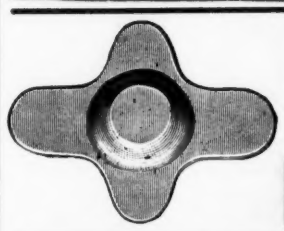

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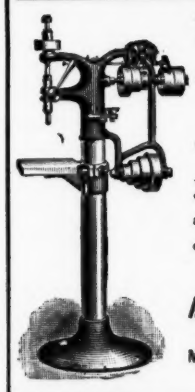

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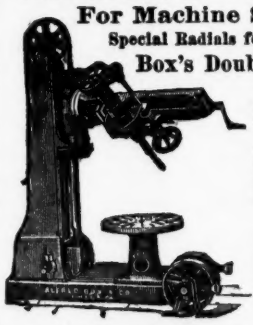

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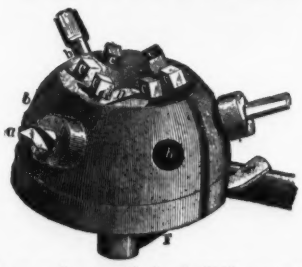

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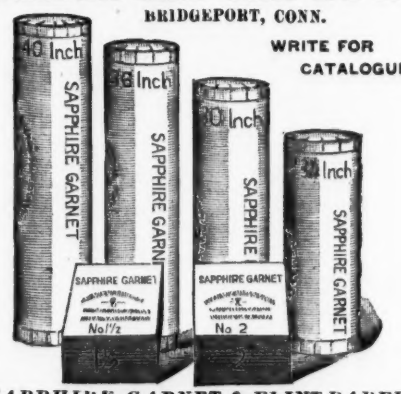

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The Straight Line Centrifugal Separator
was **NOT** included in the test recently made at Cornell University. A claim is made in another Journal that Separator **B** showed the greatest efficiency due to corrugations of interior surfaces. We not having shown our Separator in the above mentioned test, it might lead the general public to imagine we do not possess the best Separator, which we claim we do, and can show greater efficiency than any Separator on the market, in a competitive test where all Separators are represented.
I respectfully request interested parties to investigate this theory to substantiate this claim.
JOSEPH DE RYCKE,
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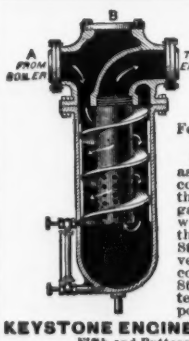
NEW YORK.



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Simpson's Centrifugal Separator and Trap.
For Supplying Clean and Dry Steam to Engines, Dry Houses, etc.
Place Separator as close to engine as possible, the steam taking a spiral course between the threads causes the water to be thrown by centrifugal force against the outer walls, while the dry steam goes through the small holes to center of pipe. Steam can enter at A or B, as convenience may require; also used in conveying steam long distances, for Steam Hammers, Dry Houses, Water Gas Generators, and for all purposes where Dry Steam is necessary.
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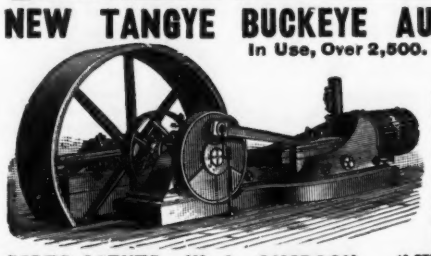
In Use, Over 2,500. 25 to 1,000 H. P.



These engines are the combined result of long experience with automatic cut-off regulation, and most careful revision of all details. They are designed and constructed for heavy and continuous duty at medium or high rotative speeds. Highest attainable Economy in Steam Consumption and superior regulation guaranteed. Self-contained Automatic Cut-off Engines 12 to 100 H. P. for Driving Dynamo Machines *a specialty*. Illustrated Circulars, with various data as to practical Steam Engine Construction and performance, free by mail. Address, BUCKEYE ENGINE CO., Salem, Ohio.

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THE WATTS, CAMPBELL CO.

MANUFACTURERS OF IMPROVED CORLISS STEAM ENGINES IN FULL VARIETY.

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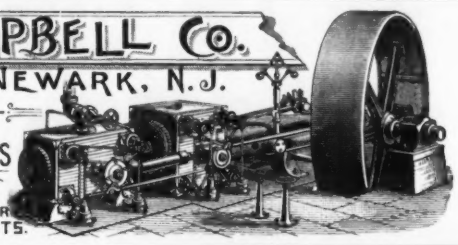

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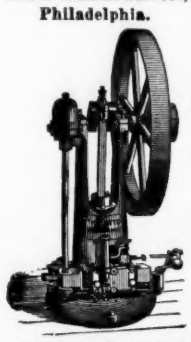

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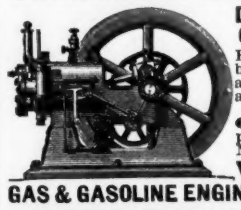

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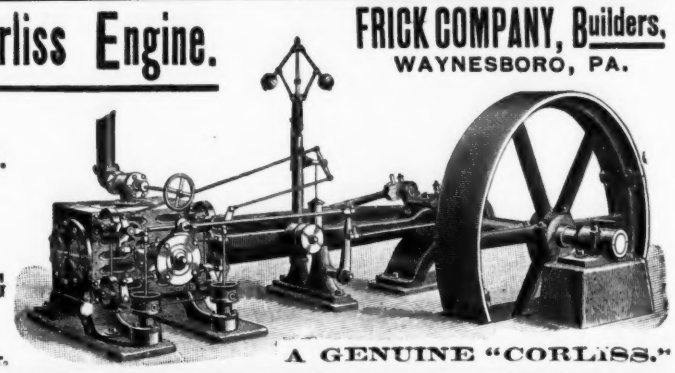

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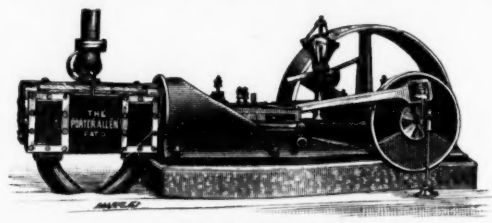

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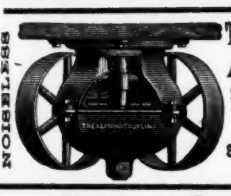

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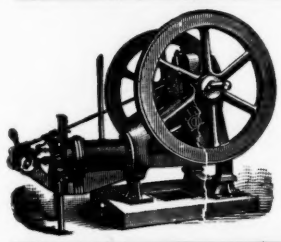

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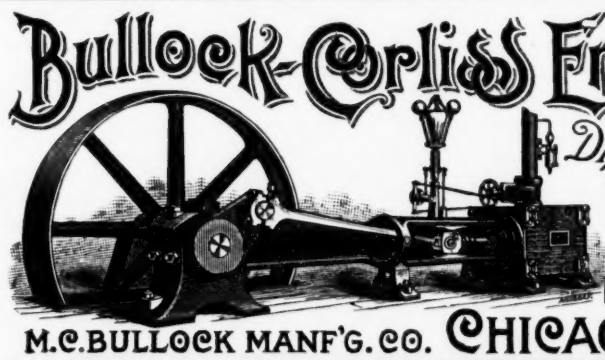

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You will make a mistake that will cost you money.

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" " 25 in. x 12 ft.,	New Haven, 2d hand, cheap	
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" " 18 in. x 6-8-10 ft.,	Hendey, Plain & Taper Att.	
" " 16 in. x 6-8-10 ft.,	" " "	
" " 16 in. x 6 8 10 ft.,	Fitchburg, Plain & Taper Atts. Compound Rests.	
" " 15 in. x 6 ft.,	Prentice, Compound Rest.	
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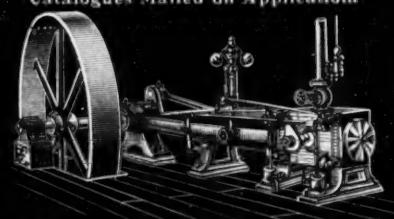

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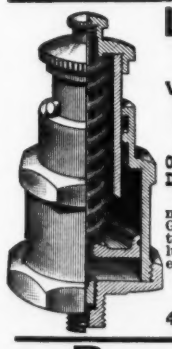

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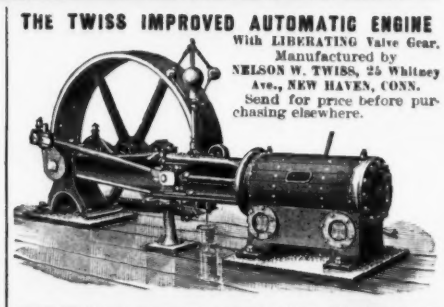

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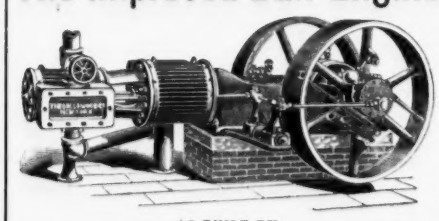

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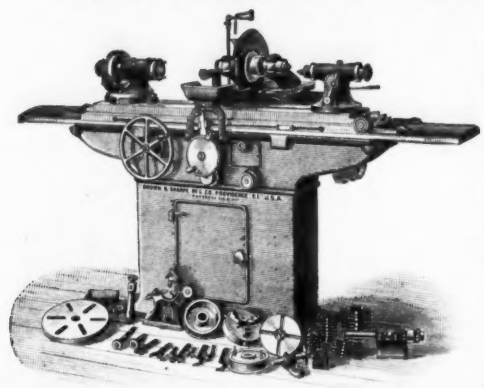

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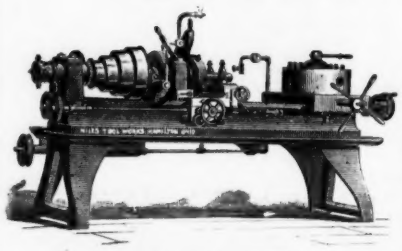

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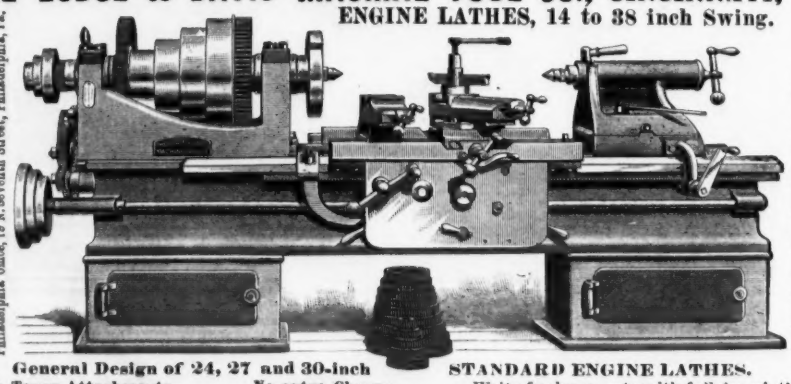

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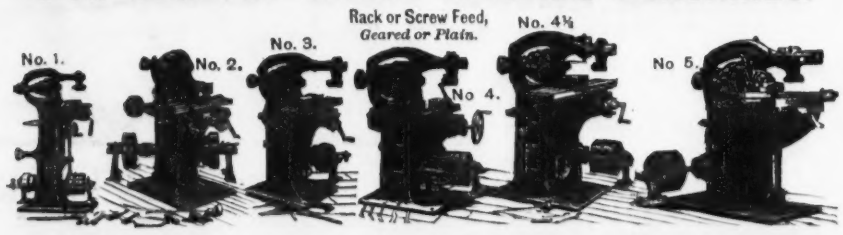

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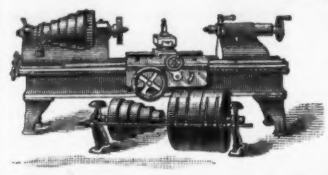

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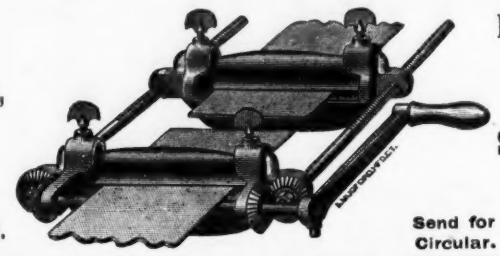

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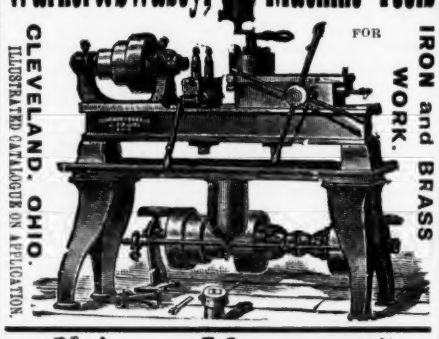

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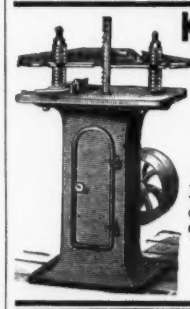

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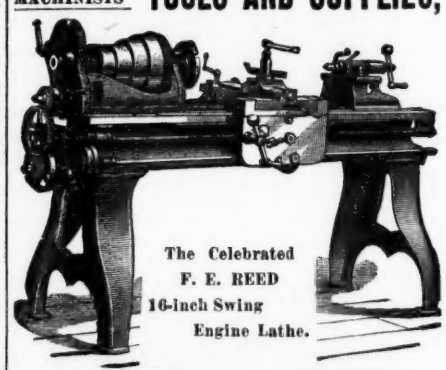

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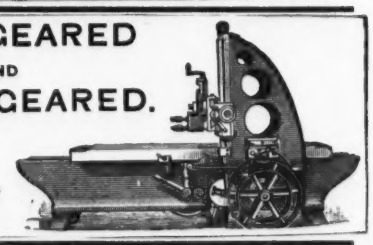

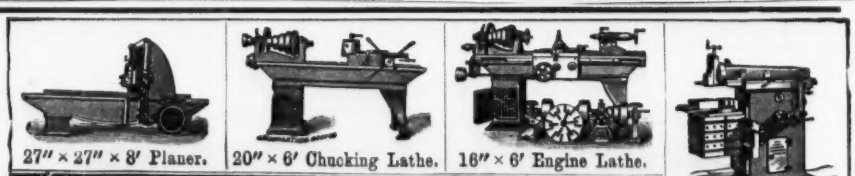

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